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ABSTRACT

This teacher's guide is designed to accompany the competency-based education student material for welding (available separately through ERIC--see note.) It consists of five sections and three appendixes. Section 1 discusses the uses of the welding competency-based curriculum along with its purpose and design. Definitions of terms used in the guide are provided in section 2. The third section contains a listing of the use of competencies by job title. Section 4 outlines the welding curriculum table of contents. The fifth section (the bulk of the guide) consists of teacher evaluation aids (task tests, module tests, and unit tests and answer keys to both the tests and the exercises included in the student curriculum package). The first appendix contains data and information on tasks currently performed and equipment used, as determined from the validation survey. The second and third appendixes include lists of additional tools and equipment used and tasks performed by respondents to the survey. (MN)

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TEACHER'S GUIDE

for

COMPETENCY-BASED EDUCATION CURRICULUM

for

WELDING

Prepared by

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December 1980

CE 028 974

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PREFACE

This competency-based education (CBE) Welding Curriculum was developed for West Virginia by Associated Educational Consultants, Inc., Pittsburgh, Pennsylvania, with the help of teachers of welding programs. The effort was coordinated by the staff of the Bureau of Vocational, Technical and Adult Education.

The Bureau began advocating CBE curriculum in 1974. Since that time, West Virginia has produced over twenty CBE curricula in various occupational areas. We also have a number of CBE curricula currently in the process of being developed and/or field-tested. This Welding curriculum was disseminated to West Virginia teachers through workshops in the Spring of 1981. Additional copies of the curriculum are available from:

Vocational Curriculum Laboratory
Cedar Lakes Conference Center
Ripley, West Virginia 25271
(304) 372-8673

I trust this curriculum will help your program. Any suggestions you may have for improving it may be sent to our State Curriculum Lab. Through this feedback we plan to continually update our materials.

VOCATIONAL, TECHNICAL AND ADULT EDUCATION

Clarence E. Burdette
Assistant State Superintendent of Schools

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The planning, organizing, and coordinating of the development of this competency-based curriculum for welding required the working together of many people of specialized skills and abilities. Associated Educational Consultants, Inc., (AEC) relied heavily on Dr. James Rosebrook and Mr. Kyle McGraw, formerly of the Bureau of Vocational, Technical and Adult Education, Mr. Marshall Hamilton, Supervisor of Trade and Industrial Education, and, particularly, Dr. Fred W. Harrington, Coordinator of Curriculum Development.

Teachers of the welding programs in West Virginia provided assistance by submitting lists of references used in their programs and information on the welding systems taught.

Several teachers gave special assistance, providing helpful suggestions and assisting in various ways at the several stages of the project. Particular recognition is due Mr. Edward Beavers, of Taylor County Vocational Center, who gave of his time on the Task Force and also served as a Content Consultant. Mr. Howard Thomas, Fayette Plateau Vocational-Technical Center, and Mr. John Pedro, Raleigh Vocational-Technical Center, also served as Content Consultants, writing Learning Activities for identified competencies. And very special thanks must be accorded to Mr. Ronald Harrington, North Hills School District, Pittsburgh, Pennsylvania, who served not only as Content Consultant, but also as advisor and coordinator.

A debt of gratitude is owed also to those many people who took time from their busy schedules to respond to the task validation survey: instructors of welding programs in West Virginia and Pennsylvania, and welders and supervisors of welders in both states.

TEACHER'S GUIDE

INTRODUCTION

This teacher's guide is designed to accompany the Welding Competency-Based Education (CBE) Curriculum. It has been developed to facilitate use of the curriculum by instructors of Welding programs.

The Teacher's Guide contains: an explanation of the curriculum and suggested usage; a list of competencies, by job title; suggested tests; and a list of references to accompany the curriculum. The appendices contain data and information on tasks currently performed and equipment used, as determined from the validation survey. There are also lists of additional tools and equipment used and tasks performed by respondents to the survey.

The competency sheets and packets, or instructional modules, in the Student Material for Welding may be used by either students or instructors, depending on your teaching style. Instructor Check Sheets in this booklet are to be used (1) by the student as a guide to standards to be attained , and (2) by the instructor to evaluate the student's performance.

In order to assure that tasks specified in the Welding curriculum conformed with current practices in West Virginia and a neighboring labor market (Pennsylvania), a survey was conducted. People who work as welders or as supervisors of welders or as teachers in Welding programs were surveyed to validate the lists of tasks and equipment. This curriculum, then, is built around the tasks which are actually performed by incumbent workers in the welding industry.

A copy of the data collected through the survey appears in this Teacher's Guide as Appendix A. You may find this data useful in working with your own advisory committee. The data are reported according to (1) state responses (West Virginia and Pennsylvania), (2) years of service in the occupation (1-5 years, 6-10 years, and more than 10 years), which can be helpful in determining entry level requirements, and (3) occupation of the respondent (welder, supervisor, instructor). You will note that there are some differences between the responses of the various groups in regard to time spent performing a task. Time spent will vary according to labor market needs and position and should be of particular importance in your instructional planning.

You should also note that there are lists of additional tools and equipment, included as Appendix B, and additional tasks performed, included as Appendix C. These were noted by respondents in relation to invitations to list any tools or tasks not appearing on the survey. Be advised that some of these "tasks" may actually be steps which are a part of the Performance Checklists on the Student Competency Sheets of the curriculum; however, the respondents' statements are included as an appendix because the respondents felt they were important enough to list.

USES OF THE

WELDING

COMPETENCY-BASED EDUCATION CURRICULUM

Curriculum Purpose

This competency-based education (CBE) curriculum, with Teacher's Guide, has been developed so that you may adapt any or all of its contents to accommodate your teaching style.

The purpose of this CBE curriculum is to provide you and your advisory committee with a set of West Virginia-validated Welding Tasks, along with (1) the Steps needed to perform each task, (2) the Evaluation Standards, and (3) suggested Learning Activities.

Depending on your teaching style, you may want to use this material primarily to assist you in your own teaching plans, or the material has been developed in enough detail so that it may, with proper supervision, be used by your students.

How you use this CBE curriculum is up to you. It has been based on the best Welding information and material available in 1978-79 in West Virginia and the United States.

Curriculum Design

The Student Competency Sheet (SCS) format has been designed for easy readibility. The Unit, or unit of instruction, is noted at the top of each page, followed by a Module title (a group of related Tasks within a Unit), and an identifying Task statement (the name of the SCS). Each Task packet is keyed; for example, I-A-1, which indicates Unit I,

Module A, Task 1. Any subsequent related pages are keyed, in the upper right-hand corner, as I-A-1, I-A-1, I-A-1, etc.
2 3 4

The first major section of the SCS is a Performance Checklist, sometimes referred to as Performance Guide or "teaching steps." These are the steps necessary to accomplish performance of the stated Task. Learning Activities are geared toward enabling the student to perform each of the steps and to understand how and why they are done. Each Performance Checklist may be used by you as an evaluative aid. The Performance Checklist may be used as both a pre-test and a post-test for professional evaluation in relation to the Standard.

The mid-section of the SCS, the Test, is laid out to define the traditional performance objective in more easily identifiable terms. The "Test" has been divided into three (3) sections. The first, Items Needed, tells exactly what equipment, etc., must be collected to perform the task. You probably will want to review these items to be sure that the listing is specific enough, that all are available in the classroom, and/or that there are not omissions of items required to perform the task according to local procedures. The second section, Task, is an itemized statement of just what the student must do to demonstrate accomplishment of the required skill. The third section, Standard, indicates how well or to what degree the skill must be demonstrated. You have the option of modifying the standard to the degree that it meets local needs.

The last section of the SCS is Learning Activities, those learning experiences which will help the student to achieve competence in each

step of the Performance Checklist. Here are listed the recommended readings in books most commonly available in State programs. Where such readings are not included in the standard texts, other recommended sources are provided. If the recommended books are not available in your school, you should substitute similar materials. Likewise, where procedural learning activities can be added or substituted according to available resources or your experience with student needs, they should be freely added.

If you wish to supplement the SCS Learning Activities, the list of kinds of activities shown on the following page may be useful to you.

Learning Activities

Audio tape
Brainstorming
Bulletin board
Buzz groups
Chalk board

Committees
Community study
Computer
Debates
Demonstration

Discovery
Discussion
Displays
Dramatizations
Drill and practice

Exhibits
Field trips/research
Film loops
Films
Filmstrips

Flannel boards
Flipchart
Games
Graphics
Homework assignment

Illustrated talk
Independent study
Information sheets
Investigation/reporting
Laboratory work

Large-group/small-group instruction
Library research
Listening
Listing or diagramming
Models

Oral recitation
Panels/symposiums
Problem solving
Programmed materials
Projects

Question and answer
Reading out loud
Real objects
Resource persons
Review

Role playing
Simulation
Slides
Speaking
Step-by-step procedure panels

Supervised study
Team teaching
Television
Transparencies
Verbal illustrations

Videotape
Visual illustrations
Work-study
Writing

DEFINITION OF TERMS

COMPETENCY	A knowledge, skill, or judgment which the learner will demonstrate at a pre-determined level.
LEARNING ACTIVITIES	Activities and resources which will assist the learners in mastering the competencies. Learning activities can range from large group activities to small group activities to individual activities.
MODULE	(1) A group of related tasks within a unit. (2) An instructional packet consisting of Student Competency Sheet, Information Sheet(s) and/or Self-Check Test(s) and/or Performance Check Sheet(s) (rating sheets).
OCCUPATIONAL SURVEY	The procedure for collecting data to identify the duties and tasks that comprise one or more jobs, job types, or career field ladders, for the collection and analysis of information concerning such duties.
PERFORMANCE CHECKLIST/ PERFORMANCE GUIDE	A series of steps arranged in a sequence ordinarily followed which, when completed, may result in the performance of a task. Also called "teaching steps."
PERFORMANCE OBJECTIVE	(See also "Test.") A statement in precise, measurable terms of a particular behavior to be exhibited by a learner under specified conditions.
TASK	A unit of work activity which constitutes logical and necessary steps in the performance of a duty. A task has a definite beginning and ending point in its accomplishment and generally consists of two or more definite steps.
TASK ANALYSIS	The process of reviewing elements of a job for the purpose of improving training program content across program levels of vocational-technical education.

TEST	The measurement of a student's ability to perform all steps necessary to complete a task satisfactorily, as measured by instructor evaluation of pre-determined levels. (1) Test, as identified on Student Competency Sheets, consists of elements which indicate the condition, or testing situation confronting the learner under specified conditions and the specific behavior expected. "Test" is composed of three (3) parts: Items Needed to perform the task, Task (what must be done to demonstrate competence), and Standard (how well, or to what standard, the skill must be demonstrated). (2) A teacher-graded evaluation of the student's written demonstration of cognitive performance.
STANDARD	The specific level of performance or quality of product which is acceptable for an entry level skill; reflects a consensus from knowledgeable people in the occupation.
UNIT	A major segment of work comprising related tasks; one of the major activities involved in the work performed.

USE OF COMPETENCIES

BY

JOB TITLE

COMPETENCIES BY JOB TITLE

Upon satisfactory completion of the specified competencies, students will be prepared to work in the following occupations, as described in the Dictionary of Occupational Titles, 4th Edition. The lists of competencies, however, should be carefully reviewed with the local Craft Advisory Committee to assure compliance with local job market requirements.

Successful preparation for all occupations will include the following competencies:

1. Look for a job
2. Write a personal data sheet (resume)
3. Complete a job application form
4. Prepare for a job interview
5. Understand yourself
6. Understand successful work attitudes
7. Use principles of human relations
8. Maintain personal safety
9. Maintain general shop safety
10. Compute whole numbers
11. Compute common fractions
12. Compute decimal fractions
13. Calculate/express percentages, averages, and estimates
14. Use basic measuring tools
15. Convert to metric values
16. Identify basic print information
17. Identify metal shapes, views, and sections
18. Interpret welding abbreviations and symbols

Group I

A. Welder Helper, D.O.T. Code 819.687-014

Performs any combination of the following duties to assist workers in welding, brazing, and thermal and arc cutting activities.

Moves workpieces, tools, and supplies, manually or by hand truck.

Lifts, moves and holds, or clamps workpieces to table, into jigs, or into position as directed, manually or by using hoist, pry bars, wrenches, hammer and wedges.

Cleans workpieces to remove impurities, such as slag, rust, and grease, using wire brush, portable grinder, hand scraper, or chemical solutions.

Connects hoses from hand torch to oxygen and fuel gas cylinders or connects cables from power source to electrode holder and workpiece or fixture.

Starts gasoline engine to activate electric generators.

Places workpieces into furnace to preheat for specified time.

Removes, tags or marks, and moves finished work.

May attach grappling equipment to objects preparatory to movement by crane.

May be designated according to type of activity as Thermal-Cutter Helper.

Suggested competencies are:

(Shielded Metallic Arc Welding Equipment)

1. Set up machine for current requirements
2. Remove or replace SMAW equipment accessories

(Gas Welding Equipment)

3. Set up portable or stationary oxy-fuel equipment
4. Change oxygen, acetylene or MAPP gas cylinders
5. Clean welding and cutting tips on oxy-fuel equipment
6. Perform soap and water and/or submerged leak test and repair gas welding equipment

(Metallic and Tungsten Inert Gas Welding Equipment)

7. Disassemble and clean a GMAW (MIG) torch assembly
8. Disassemble and clean GTAW (TIG) torch assembly

9. Select metals for fabrication from blueprint specifications
10. Clamp metal work to prevent distortion (and tack weld)
11. Examine and identify metals
12. Clean metals with solvent

13. Cut materials with hand hacksaws
14. Chip slag using chipping hammer
15. Finish metal surfaces with hand tools
16. Shear and punch metal shapes using iron working machine(s)
17. Drill metal using power drilling equipment
18. Cut metal with power hacksaw or bandsaw
19. Grind metal with power equipment
20. Set oven temperature and store arc electrodes

B. Production Line Welder, D.O.T. Code 819.684-010

Welds metal parts on production line, using previously set up gas or arc welding equipment.

Turns valves to release fuel gas and oxygen and ignites mixture, or inserts specified weld rod into portable holder, clamps cable onto workpiece or jig, and strikes arc.

Guides electrodes, or torch and filler rod, along horizontal weld line at specified speed and angle to melt and deposit metal from filler rod or electrode onto workpiece.

May skip (tack) weld designated spots to secure workpieces for other welders.

May use different equipment and be designated as Production Line Brazer, Production Line Arc Welder, Production Line Combination Welder, or Gas Welder.

In addition to the tasks listed for Welder Helper, the Production Line Welder should complete the following competencies, depending on the local employment market:

1. Shielded metallic arc-weld carbon steel
2. Shielded metallic arc-weld heat and corrosion resistant (stainless) steel
3. Shielded metallic arc-weld cast iron
4. Braze ferrous and non-ferrous metals with gas equipment
5. Silver braze ferrous and non-ferrous metals with gas equipment
6. Lead solder ferrous and non-ferrous metals with gas equipment
7. Gas weld carbon steels
8. Gas weld cast iron
9. Gas weld copper or copper alloys
10. Braze weld carbon steel
11. Set up and tack weld tee joints
12. Set up and tack weld lap joints
13. Set up and tack weld open butt joints
14. Set up and tack weld edge joints

15. Set up and make a plug or slot weld
16. Set up and tack weld in the flat position
17. Set up and tack weld in the horizontal position
18. Set up and tack weld in the vertical position
19. Set up and tack weld in the overhead position
20. Examine and identify metals

C. Welder Assembler, D.O.T. Code 819.381-010

Assembles and tack-welds steel frames and other component parts of machinery and equipment in preparation for final welding.

Measures and marks locations for metal components on assembly table, following blueprints.

Lifts and positions components on assembly table, using electric crane, jacks, and shims.

Verifies position of metal components in assembly, using straightedge, combination square, calipers, and rule.

Clamps metal components to assembly table for welding.

Removes rough spots from castings, using portable powered grinder and hand file, to fit and assemble parts.

Tack-welds parts in preparation for final welding.

Moves assembly to storage area, using electric crane.

The competencies listed in Parts A and B (Welder Helper and Production Line Welder) may be applicable to Welder Assembler.

Group II. ARC WELDING

A. Tack Welder, D.O.T. Code 810.684-010

Welds short beads at points specified by layout, welding diagram, or by Fitter, along overlapping edges of metal parts to hold parts in place for final welding.

Performs tasks of Fitter Helper.

May tack weld, using hand, submerged, or gas-shielded arc welding equipment.

May tack weld, using portable spotwelding gun (Gun Welder).

Suggested minimum competencies:

1. All tasks of Unit I--Operating Shielded Metallic Arc Welding Equipment (9 tasks)
2. All tasks of Unit IV--Set up and Tack Weld Different Joints (13 tasks)
3. All tasks of Unit V--Clean, Test, and Classify Metals (4 tasks)
4. All tasks of Unit VI--Operating Auxiliary Equipment and Tools (8 tasks)
5. Prepare and weld pipe joints

B. Arc Welder, D.O.T. Code 810.384-014

Welds together metal components of such products as pipelines, automobiles, boilers, ships, aircraft, and mobile homes, as specified by layout, blueprints, diagram, work order, welding procedures, or oral instructions, using electric arc-welding equipment. Obtains specified electrode and inserts into portable holder or threads consumable electrode wire through portable welding gun.

Connects cables from welding unit to obtain amperage, voltage, slope, and pulse, as specified by Welding Engineer or Welding Technician.

Starts power supply to produce electric current.

Strikes arc which generates heat to melt and deposit metal from electrode to workpiece and join edges of workpiece.

Manually guides electrode or gun along weld line, maintaining length of arc and speed of movement to form specified depth of fusion and bead, as judged from color of metal, sound of weld, and size of molten puddle.

Welds in flat, horizontal, vertical, or overhead position.

Examines weld for bead size and other specifications.

May manually apply filler rod to supply weld metal.

May clean or degrease weld joint or workpiece, using wire brush, portable grinder, or chemical bath.

May repair broken or cracked parts and fill holes.

May prepare broken parts for welding by grooving or scarfing surfaces.

May chip off excess weld, slag, spatter, using hand scraper or power chipper.

May preheat workpiece, using hand torch or heating furnace.

May position and clamp workpieces together or assemble them in jig or fixture.

May tack assemblies together.

May cut metal plates or structural shapes (Arc Cutter).

May be designated according to type of equipment uses as: Carbon Arc Welder, Flux-Cored Arc Welder, Gas Metal Arc Welder, Tungsten Arc Welder, Submerged Arc Hand Welder, Plasma Arc Welder, Shielded Metal Arc Welder.

May be designated according to product as Welder, Boilermaker.

Important variations include types of metals welded, sub-processes used, trade name of equipment used, worksite (in-plant, job shop, construction site, shipyard), method of application (manual, semi-automatic), high-production or custom, level of ambidexterity required, type of joints welded (seam, spot, butt).

May be required to pass employer performance tests or standards tests to meet certification standards of governmental agencies or professional and technical associations.

In addition to the tasks listed for Tack Welder, the Arc Welder should complete the following competencies, depending on the local employment market:

1. All tasks of Unit VII--Performing Structural or Equipment Welding and Cutting Operations (9 tasks)
2. All tasks of Unit VIII-Welder Certification Test

C. Arc Welding Machine Operator, D.O.T. Code 810.382-010

Sets up and operates arc welding machine that welds together parts of fabricated metal products, as specified by blueprints, layouts, welding procedures, and operating charts:

Welds flat, cylindrical, or irregular parts that may be clamped, tack-welded, or otherwise positioned.

May position weld line parallel to carriage.

Turns cranks or pushes buttons to aline electrode on welding head over weld joint to weld linear joints, or adjust length of radial arm to position electrode over weld joint when welding radial joints.

Clamps cylindrical workpieces onto turning rolls under stationary head to weld circular joints.

Threads specified electrode wire from reel through feed rolls and welding head.

Turns welding head to set specified angle of electrode.

May fill hopper with specified flux and direct nozzle or gravity feed over weld line, or adjust shielding gas or gas mixture flow rate.

Turns knobs to set current, voltage, and slope, and synchronize feed of wire and flux with speed of welding action.

May set limit switch which automatically stops machine at end of weld.

Starts machine and observes meters and gages, or observes welding action for compliance with procedures.

Visually examines welds for adherence to specifications.

May grind welded surfaces for penetrant test.

Adjusts machine setup to vary size, location, and penetration of bead.

May install track template to weld irregularly-shaped seams.

May make trial run before welding and record setup and operating data.

May layout, fit, and tack workpieces together.

May preheat workpiece, using hand torch or heating furnace.

May reheat defective joints, using hand welding equipment.

May remove surplus slag, flux, and spatter, using brush, portable grinder, and hand scraper.

May operate machine equipped with two or more heads.

May be designated according to type of welding machine operated as: Electro-Gas Welding Machine Operator, Gas Metal Arc Welding Machine Operator, Plasma Arc Welding Machine Operator, or Submerged Arc Welding Machine Operator.

Competencies suggested for Arc Welder should be reviewed according to local employment requirements and the student's career goals.

Group III. GAS WELDING

A. Gas Welding Machine Operator, D.O.T. Code 811.482-010

Sets up and operates oxy-fuel-gas-welding machine to weld metal parts, according to work order, blueprints, layout, and operating charts.

Clamps workpieces into holding fixture on machine bed, movable carriage or turntable.

Positions and clamps or bolts welding torch onto overhead carriage, radial arm, or into stationary fixture at specified angle and distance from workpiece.

Turns cranks to aline torch with weld line.

Selects torch tip, filler wire, and flux, according to charts or thickness and type of metal.

Fills hoppers with flux and positions spout over weld line.

Places reel of filler wire onto spindle and threads end through feed rolls to welding seam.

Connects hoses from torch to regulator valves and cylinders of oxygen and fuel gas.

Turns regulator valves to start flow of gases, lights torch, and adjusts gas mixture and pressure to obtain flame of desired size and color.

Turns knobs to synchronize movement of torch or workpiece, feed of flux, and filler with welding action, and sets switch to stop machine at end of weld.

Starts machine, observes welding action, and examines weld for defects.

Adjusts machine set up to vary bead size and other weld characteristics.

May record setup and operating data.

May reweld defective joints, using hand torch.

May preheat workpiece in furnace.

May layout, fit, and tack-weld workpieces together.

May operate machine equipped with two or more welding torches.

May remove surplus flux, slag, and spatter, using wire brush, portable grinder, and hand scraper.

Suggested competencies to be completed:

1. Should be familiar with procedures for accomplishing tasks in Unit I--Operating Shielded Metallic Arc Welding Equipment (8 tasks)
2. All tasks in Unit II--Operating Gas Welding Equipment (16 tasks)
3. Should be familiar with procedures for accomplishing tasks in Unit III--Operating Metallic and Tungsten Inert Gas Welding Equipment (11 tasks)
4. All tasks in Unit IV--Set Up, Tack, and Weld Metal Processing Projects (13 tasks)
5. All tasks in Unit V--Clean, Test, and Classify Metals (4 tasks)
6. All tasks in Unit VI--Operating Auxiliary Equipment and Tools (8 tasks)
7. Should be familiar with procedures for accomplishing tasks in Unit VII-Performing Structural or Equipment Welding and Cutting Operations

B. Gas Welder, D.O.T. Code 811.684-014

Welds metal parts, using gas welding equipment as specified by layout, welding diagram, or work order.

Positions parts in jigs or fixtures on bench or floor, or clamps parts together along layout marks.

Selects torch, torch tip, filler rod and flux, according to welding chart specifications or type and tickness of metal.

Connects regulator valves and hoses to oxygen and fuel gas cylinders, and welding torch.

Turns regulator valves to activate flow of gases, lights, torch and adjusts gas mixture and pressure, to obtain desired flame, based on knowledge of gas-welding techniques.

Holds torch at proper angle to metal and guides along weld joint, applying filler rod to molten area to form weld.

Examines weld for bead size and other specifications.

Repairs broken or cracked metal objects, fills, holes, and builds up metal parts.

May apply flux to workpiece instead of filler rod.

May preheat workpiece in furnace or with torch.

May layout, position, and tack weld workpieces.

May weld along vertical or overhead lines.

May scarf or goove weld prior to applying filler metal, using gas welding equipment.

May chip or grind off excess weld, slag, or spatter (Grinder-Chipper).

May clean or degrease parts, using wire brush, portable grinder, or chemical bath.

May cut metal plates or structural shapes using gas torch.

May be designated according to type of gases used as Acetylene Welder, Oxyacetylene Welder, or Oxyhydrogen Welder.

Important variations include type of metals welded, products, subprocesses, trade name of equipment, worksite (in-plant, job shop, construction site, shipyard), high-production or custom, level of ambidexterity required or type of joints welded (seam, spot, butt).

May be required to pass employer performance tests or standard tests to meet certification standards of governmental agencies or professional and technical associations.

Suggested competencies to be completed:

1. Should be familiar with procedures for accomplishing tasks in Unit I--Operating Shielded Metallic Arc Welding Equipment (8 tasks)

2. All tasks in Unit II--Operating Gas Welding Equipment (16 tasks)
3. Should be familiar with procedures for accomplishing tasks in Unit III--Operating Metallic and Tungsten Inert Gas Welding Equipment (11 tasks)
4. All tasks in Unit IV--Set Up, Tack, and Weld Metal Processing Projects (13 tasks)
5. All tasks in Unit V--Clean, Test, and Classify Metals (4 tasks)
6. All tasks in Unit VI--Operating Auxiliary Equipment and Tools (8 tasks)
7. All tasks in Unit VII--Performing Structural or Equipment Welding and Cutting Operations (9 tasks)
8. All tasks in Unit VIII--Welder Certification Test (3 tasks)

Group IV. COMBINATION WELDING

A. Combination Welder Apprentice, D.O.T. Code 819.384-008

and

B. Combination Welder, D.O.T. Code 819.384-010

Welds metal components together to fabricate or repair products, such as machine parts, plant equipment, mobile homes, motors, and generators, according to layouts, blueprints, or work orders, using brazing and variety of arc and gas welding equipment.

Welds metal parts together, using both gas welding (Gas Welder), brazing (Brazer, Assembler), and any combination of arc welding processes (Arc Welder).

Performs related tasks, such as thermal cutting and grinding.

Repairs broken or cracked parts, fills, holes, and increases size of metal parts.

Positions and clamps together components of fabricated metal products preparatory to welding.

May locate and repair cracks in industrial engine cylinder heads, using inspection equipment and gas torch, and be designated Cylinder Heads Repairer.

May perform repairs only, and be designated Repair Welder.

May be required to pass employer performance tests or standard tests to meet certification standards of governmental agencies or professional and technical associations.

C. Welder-Fitter, D.O.T. Code 819.361-010

Layouts, fits, and welds fabricated, cast, and forged components to assemble forms, such as machinery frames, tanks, pressure vessels, furnace shells, and building and bridge parts, according to blueprints and knowledge of welding and metallurgy.

Selects equipment and plans layout, assembly, and welding, applying knowledge of geometry, physical properties of metal machining weld shrinkage, and welding techniques.

Lays out, positions, alines, and fits components together.

Bolts, clamps, and tack-welds parts to secure in position for welding (Tack Welder).

Sets up equipment and welds parts, using arc, gas-shielded arc, submerged arc, or gas welding equipment (Combination Welder).

May assemble parts by bolting and riveting.

May repair products by dismantling, straightening, reshaping, and reassembling parts, using cutting torch, straightening press, and hand tools, and be designated Structural Repair Welder.

May specialize in using one welding process and be designated Arc Welder-Fitter or Gas Welder-Fitter.

May specialize in fitting and welding components of metal tools, dies, and fixtures and be designated Tool and Die Welder.

It is suggested that the student who aspires to occupations which require skills in this group should be familiar with all competencies in Units I through VIII. The student and the teacher should review the requirements of the occupation(s) which most interest the student and then select competencies in which proficiency must be demonstrated.

Group V

The occupations in this group are examples of supervisory positions.

A. Lead Burner Supervisor, D.O.T. Code 819.131-010

Supervises and coordinates activities of workers engaged in burning (welding) lead and lead alloy parts according to blueprints, specifications, or orders, applying knowledge of melting characteristics of lead.

Directs workers and participates in fabricating, installing, and repairing equipment, such as lead pipes, floors, valves, and tank linings.

Interprets drawings and specifications and orders materials.

B. Welding Supervisor, D.O.T. Code 819.131-014

Supervises and coordinates activities of workers engaged in welding and cutting of products and structures, such as auto, aircraft, and ship components, pipes, boilers, and mobile homes, applying knowledge of welding and cutting techniques, materials, and equipment, and fabrication requirements.

Analyzes work orders and blueprints to determine need for supplies and sequence of operations required.

Requisitions supplies, such as weld rods, gas, flux, and fixtures.

Inspects work or confers with Weld Inspector to maintain specified standards and quality.

Trains workers in operation of equipment.

May set up machines or make trial welds to make test runs and experimental products.

May supervise brazing and soldering operations.

May supervise fitting and assembly of structural frames.

May supervise workers engaged in making tubing from flat steel strips by electric weld process and be designated Electric Weld Pipe Mill Supervisor.

Important variations include location of workers supervised, such as in-plant, job shop, construction site, or shipyard.

Performs other duties as described under Supervisor.

Depending upon their proficiency in performing welding tasks and upon their career goals, some students aspire to eventual supervisory positions. For these students, the tasks in Unit IX--Supervision,

Training, and Job Estimating--are of particular value. It is recommended, however, that all students become familiar with these tasks: familiarity with the role and responsibility of supervisors is important to workers in order that they might understand the complexities and inter-relationships of the work of others.

WELDING CURRICULUM

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WELDING CURRICULUM

TABLE OF CONTENTS

UNIT MODULE TASK

A. Employment Opportunities

1. Look for a job
2. Write a personal data sheet (resume)
3. Complete a job application form
4. Prepare for a job interview

B. Human Relations

1. Understand yourself
2. Understand successful work attitudes
3. Use principles of human relations

C. Safety

1. Maintain personal safety
2. Maintain general shop safety

D. Basic Mathematics

1. Compute whole numbers
2. Compute common fractions
3. Compute decimal fractions
4. Calculating/expressing percentages, averages, and estimates

E. Measuring

1. Use basic measuring tools
2. Convert to metric values

F. Reading Blueprints

1. Identify basic print information
2. Identify metal shapes, views, and sections
3. Interpret welding abbreviations and symbols

I. Operating Shielded Metallic Arc Welding Equipment

A. Equipment Set Up

1. Set up machine for current requirements
2. Remove or replace SMAW equipment accessories

B. Welding

1. Shielded metallic arc-weld carbon steel
2. Shielded metallic arc-weld heat and corrosion resistant (stainless) steel
3. Shielded metallic arc-weld cast iron

C. Cutting and Build-up/Hard Surfacing

1. Hard surface steel with arc-welding equipment
2. Cut carbon steel using shielded metallic arc cutting process
3. Cut carbon steel with air carbon arc process
4. Cut cast iron with air carbon arc process

II. Operating Gas Welding Equipment

A. Equipment Set Up and Maintenance

1. Set up portable or stationary oxy-fuel equipment
2. Change oxygen, acetylene or MAPP gas (methyl-acetylene propadiene) cylinders
3. Clean welding and cutting tips on oxy-fuel equipment
4. Perform soap and water and/or submerged leak test and repair gas welding equipment

B. Cutting and Shaping Materials

1. Cut carbon steels with oxy-acetylene equipment
2. Forge metals with gas equipment
3. Shape metals using gas welding equipment
4. Remove distortion using gas welding equipment

C. Brazing and Soldering

1. Braze ferrous and non-ferrous metals with gas equipment
2. Silver braze ferrous and non-ferrous metals with gas equipment
3. Lead solder ferrous and non-ferrous metals with gas equipment

UNIT MODULE TASK (Continued)

D. Welding and Braze Welding

1. Gas weld carbon steels
2. Gas weld cast iron
3. Gas weld copper or copper alloys
4. Braze weld carbon steel
5. Braze repair cast iron castings

III. Operating Metallic and Tungsten Inert Gas Welding Equipment (TIG), (MIG)

A. Equipment Maintenance

1. Disassemble and clean a GMAW (MIG) torch assembly
2. Disassemble and clean a GTAW (TIG) torch assembly

B. Welding with MIG Equipment

1. Weld carbon steels with GMAW (MIG) equipment
2. Weld stainless steel alloys with GMAW (MIG) equipment
3. Weld aluminum or aluminum alloys with GMAW (MIG) equipment

C. Welding with TIG Equipment

1. Weld carbon steels with GTAW (TIG) equipment
2. Weld aluminum or aluminum alloys with GTAW (TIG) equipment
3. Weld heat and corrosion resistant (stainless) steels with GTAW (TIG) equipment
4. Weld copper or copper alloys with GTAW (TIG) equipment
5. Weld chrome-moly steel with GTAW (TIG) equipment
6. Weld magnesium alloys with GTAW (TIG) equipment

IV. Set Up, Tack and Weld Metal Processing Projects

A. Organizing for Welding

1. Research technical publications for welding standards
2. Draw sketches for shop or field projects
3. Select metals for fabrication from blueprint specifications
4. Clamp metal work to prevent distortion and tack weld

UNIT MODULE TASK (Continued)

B. Set Up and Tack Weld Different Joints

1. Set up and tack weld tee joints
2. Set up and tack weld lap joints
3. Set up and tack weld open butt joints
4. Set up and tack weld edge joints
5. Set up and make a plug or slot weld

C. Set Up and Tack Weld in Different Positions

1. Set up and tack weld in the flat position
2. Set up and tack weld in the horizontal position
3. Set up and tack weld in the vertical position
4. Set up and tack weld in the overhead position

V. Clean, Test and Classify Metals

A. Clean, Test and Classify Metals

1. Examine and identify metals
2. Clean metals with solvent
3. Test metals using guided bend tester
4. Inspect welds using dye penetrant methods

VI. Operating Auxiliary Equipment and Tools

A. Hand Tools

1. Cut materials with hand hacksaws
2. Chip slag using chipping hammer
3. Finish metal surfaces with hand tools

B. Power Tools

1. Shear and punch metal shapes using iron working machines
2. Drill metal using power drilling equipment
3. Cut metal with power hacksaw or bandsaw
4. Grind metal with power equipment

C. Use Rod Oven

1. Set oven temperature and store arc electrodes

VII. Performing Structural or Equipment Welding and Cutting Operations

A. Work Order - Applications

1. Fabricate or repair tubing systems

UNIT MODULE TASK (Continued)

2. Reconstruct and align frames or related equipment
3. Fabricate protective devices for windows and openings
4. Fabricate metal reinforcing devices for structural foundations
5. Fabricate metal work stands or furniture
6. Fabricate or construct storage devices

B. Work Order - Advanced Applications

1. Fabricate aluminum structures or devices
2. Fabricate corrosion resistant steel
3. Prepare and weld pipe joints

VIII. Welder Certification Test

A. Procedure

1. Preparation for testing
2. Plate test
3. Pipe test

IX. Supervision, Training, and Job Estimating

A. Job Estimating

1. Estimate labor and materials costs of new fabrication
2. Estimate cost of repairs

B. Training

1. Write performance standards for jobs
2. Plan and conduct on-the-job training for employees
3. Conduct oral safety briefings
4. Improve work methods

C. Supervision

1. Plan and schedule work assignments
2. Assign work to others
3. Prepare annual shop budget
4. Receive and record new shipment of supplies
5. Interview job applicants
6. Prepare accident report

TEACHER EVALUATION AIDS

AND

ANSWER KEYS

EVALUATION AIDS

PREFACE

Three types of tests are included in this section. You are cautioned against using any of the example tests without adequate review and selection.

Task Tests. Task tests are keyed according to Unit, Module, and Task numbers; for example, a test marked I-A-1 would key the test to Unit I, Module A, Task 1. You may use it as a teacher-graded test, or may believe it more useful as a learning tool. Thus, you have the option of administering the test and evaluating the answers, or distributing the questions and the answer key as a self-check test.

Module Tests. Module tests are keyed according to Unit and Module; for example, a test marked I-A would key the test to Unit I, Module A, and the test should measure learning associated with the tasks within that module.

Unit Tests. Unit tests are keyed to each of the units. They are indicated for example, as Unit Test, Unit A--Employment Opportunities. The unit tests may be utilized to measure learning as related to the entire unit, or they may be altered, supplemented, or reduced to measure the learning of selected tasks or modules.

The format of a major examination is critical in the appropriate and valid measurement of learning. Likewise, the structure and format of a unit test should present the written examination as a learning tool and not be seen as unusual or unlike learning activities in which the student has participated.

Teacher Evaluation

Unit A: EMPLOYMENT OPPORTUNITIES

Part I. True-False (20 points, two (2) for each correct answer)

Circle the correct answer:

1. T F The personal data sheet is often called a resume.

2. T F A personal data sheet includes more information than you'll need to provide on a job application form or in an interview.

3. T F Personal references are a waste of time. Employers never call them anyhow.

4. T F Having a Social Security card guarantees that you'll be given a job.

5. T F You don't have to tell prospective employers whether you're single, married, or divorced.

6. T F A letter of application is written only when applying for office jobs.

7. T F It's sometimes all right to look at your pre-written list of questions to be asked and items to be discussed during the interview.

8. T F Emphasizing your own good points during an interview makes you appear conceited.

9. T F If the interviewer has not said "no," it's all right to call back in a week or two to remind the company that you're still interested.

10. T F You should put something in all the blanks on a job application form except those marked for company use.

Part II. Multiple Choice (20 points, two (2) for each correct answer)

Circle the correct answer (a, b, or c)

11. The D.O.T. number is:

    a. The code which describes a job.
    b. The projected number of employees needed in an occupational field.
    c. The telephone number of the Bureau of Employment Security.

Unit A Test (continued)

12. State welding certification is:

    a. A license to teach welding.
    b. Not required in industry.
    c. A license to perform specific kinds of welding.

13. When writing out your work experience record:

    a. Start with the most recent job and work backwards.
    b. Start with the first job and work toward what you have done most recently.
    c. The order of the jobs doesn't matter.

14. If an interviewer asks something you don't know or asks if you can do something you've never tried or cannot do, it's best to:

    a. Not answer at all.
    b. Fake it.
    c. Be honest.

15. In most companies, the interviewer:

    a. Hires the employees.
    b. Screens the applicants.
    c. Sets the wage or salary rate.

16. A supervisor is:

    a. A person or company who hires people.
    b. An individual who depends upon you for their support.
    c. A person who works for another person or company.

17. Gross pay is:

    a. The amount that is taken home.
    b. The total amount paid before deductions.
    c. The hourly rate of pay.

18. A job application:

    a. Helps the interviewer judge your ability to follow directions.
    b. Usually asks for unimportant information.
    c. Tells nothing about you except the words that you have written.

Unit A Test (continued)

19. Salary should be discussed:

    a. First thing during the interview.
    b. At the end of the interview.
    c. Not at all.

20. Looking the interviewer in the eye is:

    a. A way to show you're listening and interested.
    b. Not necessary as long as you're listening.
    c. Rude.

Part III. Define (20 points, two (2) for each correct answer)

21. Fringe benefits
22. Ethnic group
23. Nationality
24. Marital status
25. Dependent
26. Management
27. Salary
28. Wage
29. Limitations
30. Deduction

Part IV. List the five (5) major kinds of welding. (15 points, three (3) for each correct answer)

1.
2.
3.
4.
5.

Part V. List the duties of a welder. (25 points, to be evaluated by the instructor. May be those listed in the Dictionary of Occupational Titles for Combination Welder or Welder, Production Line, or from lecture by instructor. Must include all main duties.)

Answer Key - Teacher Evaluation

Unit A Test: EMPLOYMENT OPPORTUNITIES

I.
1. True
2. False
3. False
4. False
5. True
6. False
7. True
8. False
9. True
10. True

II.
11. a
12. c
13. a
14. c
15. b
16. c
17. b
18. a
19. b
20. a

III.
21. Things given an employee other than money
22. Caucasian (white), negroid (black), Indian, Asian, other
23. Country where a person is born
24. Single, married, divorced, or widowed
25. An individual who depends upon you for support
26. Those who make decisions
27. Monthly or yearly contract payments
28. The hourly rate of pay
29. Health or physical condition that may hinder a person on the job
30. That which is taken from a pay check

IV.
31. Stick welding (oxy-acetylene)
32. TIG
33. MIG
34. Sub-arc (submerged arc)
35. Flux core

V. (To be evaluated by the instructor)

Teacher Evaluation

Unit B: HUMAN RELATIONS Task 1: Understand Yourself

Read the following list of words. Find the word which best fills in the blank in the corresponding statements. Place the letter in the blank provided at the left of the statement.

A. personal appearance
B. able
C. foresight
D. health habits
E. punctuality
F. tact
G. courtesy
H. attitude toward other people
I. dependable
J. sense of humor
K. self-control
L. open-mindedness
M. morality
N. honesty
O. initiative
P. aptitude

_____ 1. When we say that people have ability to do something, we mean they are _____ to do it.

_____ 2. When people seem to be born with natural talent which makes it easy to learn certain things, we say that they have _____ for these things.

_____ 3. The value which has the greatest effect upon your personality shows in your _____.

_____ 4. _____ means having two things: good manners and a true concern for the comfort of others.

_____ 5. People who always complete the work given them on the job are _____.

_____ 6. To look and plan ahead displays _____.

_____ 7. Good _____ help you feel, act, and look your best.

_____ 8. If you can see that things need to be done and do them, you have _____.

_____ 9. Being able to see both sides of a question or argument means _____.

_____10. Being on time describes _____.

_____11. If you can see the funny side of life, you have a _____.

_____12. If you can say the right thing at the right time, and handle situations so that no one becomes offended you possess _____.

Answer Key - Teacher Evaluation

Unit B: HUMAN RELATIONS Task 1: Understand Yourself

1. B - able
2. P - aptitude
3. H - attitude toward other people
4. G - courtesy
5. I - dependable
6. C - foresight
7. D - health habits
8. O - initiative
9. L - open-mindedness
10. E - punctuality
11. J - sense of humor
12. F - tact

Teacher Evaluation

Unit B: HUMAN RELATIONS Task 2: Understanding Successful Work Attitudes

Answer each by circling "T" for true, or "F" for false. You must answer twelve (12) out of 15 correctly. No references may be used.

T F 1. The most important factor in job success is attitude.

T F 2. About two-thirds of the young workers who lose their jobs do so because of poor attitude.

T F 3. Those who are most agreeable to take on unpleasant tasks are often the first to be awarded with pay increases.

T F 4. It is not important to be friendly with your co-workers.

T F 5. If you cannot be loyal to your employer and your company, you should look for another job.

T F 6. Regardless of how a criticism was meant, it is constructive or destructive depending on how you use it.

T F 7. If you are too ill to go to work, it is best to stay home, and then let the employer know why you missed work as soon as you are well.

T F 8. It is not fair for an employer to criticize your work until you have had time to learn the job.

T F 9. Most employers like workers who follow directions exactly as given.

T F 10. The behavior we develop by the time we leave high school affects us for the rest of our lives.

T F 11. The ability to get along with others is something that you are "born with" - it can't be learned.

T F 12. Written evaluations of your work by your employer are legal.

T F 13. A sense of humor is the ability to laugh when the joke is on you.

T F 14. Criticism is necessary in the job situation.

T F 15. It is best to become close friends with a co-worker during the first week or two on the job.

Answer Key - Teacher Evaluation

Unit B: HUMAN RELATIONS Task 2: Understanding Successful Work Attitudes

1. T
2. T
3. T
4. F
5. T
6. T
7. F
8. F
9. T
10. T
11. F
12. T
13. T
14. T
15. F

Activity Test

Unit B: HUMAN RELATIONS Task 2: Understanding Successful Work Attitudes

"5-Minute Timed Test on Following Directions"

How well do you follow directions? You should be able to complete all the things required in five (5) minutes by following the directions below. Your teacher may wish to time you to see who can finish first, second, etc., so turn your paper over to show when you have completed all the work.

Do not begin until your teacher says "go," then follow directions exactly as given. You will need one (1) sheet of notebook paper.

1. Read all directions before doing anything.
2. On a sheet of notebook paper, write your name in the upper right corner.
3. Number from one (1) to seven (7), leaving three (3) blank lines between each number.
4. Draw five (5) small squares beside the number one (1) on your paper.
5. Put an "X" in each square beside number one (1).
6. Put a circle around the number two (2) on your paper.
7. Count the number of pages in Chapter Four (4) of your book and write the answer beside number three (3) on your paper.
8. Multiply the answer above by your age.
9. Say your name out loud.
10. Beside number four (4), write today's date.
11. Beside number five (5), write the city and state where you were born.
12. Count the number of persons in the room and write the answer beside number six (6).
13. Say, "I have reached number 13, and I am following directions carefully."
14. Now that you have completed the reading, omit all directions except the first two (2).

Teacher Evaluation

Unit B: HUMAN RELATIONS Task 3: Using Principles of Human Relations

The following true/false questions deal with the Principles of Human Relations. Place a circle around the letter which represents the correct answer.

T F 1. The ability to make things happen is important both in your social life and in your career.

T F 2. Some things we do for no reason at all.

T F 3. We are more effective in our human relationships if we know why others behave as they do.

T F 4. Everything we do is because we want something.

T F 5. Leaders are "born," not "made."

T F 6. Human beings usually behave on the basis of what is logical.

T F 7. Everyone has some feelings of insecurity.

T F 8. Showing a sincere interest in someone can help you influence that person.

T F 9. Although a smile may be useful in your social life, it is of little value in your career.

T F 10. Putting up a good argument will help you influence others.

T F 11. Catching other people in the right mood is an important factor in making them behave as you would like.

T F 12. Once you can show that another person has made a mistake, it is important that you get him or her to admit it.

T F 13. Everyone has a basic need to feel important.

T F 14. It is easier to influence another with praise than with criticism.

T F 15. You can tell a great deal about a person by observing his or her mannerisms.

Answer Key - Teacher Evaluation

Unit B: HUMAN RELATIONS Task 3: Using Principles of Human Relations

1. T
2. F
3. T
4. T
5. F
6. F
7. T
8. T
9. F
10. F
11. T
12. F
13. T
14. T
15. T

Teacher Evaluation

Unit B: HUMAN RELATIONS

Part I. True-False (25 points, five (5) for each correct answer)

Circle the correct answer:

1. T F The most important factor in job success is how well you perform the technical skills.

2. T F It's just as important to be a good follower as a good leader.

3. T F Morality is the value which has the greatest effect upon your personality.

4. T F Personal hygiene and good grooming are related to ethics.

5. T F Having to rely on another person for help or support of any kind makes a person unethical.

Part II. Multiple Choice (25 points, five (5) for each correct answer)

Circle the correct answer (a, b, c, or d):

6. A natural talent which makes it easy to learn certain things is:

   a. Ability
   b. Interest
   c. Aptitude
   d. Foresight

7. Having good manners and a true concern for the comfort of others is:

   a. Self-control
   b. Courtesy
   c. Tact
   d. Sense of humor

8. Being able to see both sides of a question or argument:

   a. Morality
   b. Open-mindedness
   c. Duplicity
   d. Initiative

Unit B Test (continued)

9. The ability to get along with others:

   a. Something you are born with
   b. Honesty
   c. Punctuality
   d. Learned

10. Authorization by the state to practice welding:

   a. Certification
   b. Licensure
   c. Litigation
   d. Consent

Part III. Completion (25 points, five (5) points each)

Write the word that completes the statement in the blank to the left of the statement:

11. _____ A _____ acts as a bridge between the people who run the company and the employees.

12. _____ Your _____ is determined by how well your needs are satisfied, how others react to you, and how closely you measure up to the ideal you have set for yourself.

13. _____ A _____ is an established pattern of behaving in relation to other people.

14. _____ _____ is the exchange of information, feelings, and ideas which is the basis for the development of relationships among people.

15. _____ If you can handle situations so that no one becomes offended and if you say the right thing at the right time, you possess _____.

Answer Key - Teacher Evaluation

Unit B Test: HUMAN RELATIONS

I.
1. False
2. True
3. False
4. True
5. False

II.
6. c
7. b
8. b
9. d
10. a

III.
11. Supervisor
12. Self-concept
13. Role
14. Communications
15. Tact

Teacher Evaluation

Unit C: SAFETY

ON A SEPARATE SHEET(S) OF PAPER, PRINT THE ANSWERS TO THE FOLLOWING QUESTIONS:

I. According to the federal safety color code, the following items or situations are indicated by what color? Print the name of the color. (Two (2) points each)

1. Portable containers of flammable liquid
2. Caution, and for marking physical hazard
3. Emergency stop bars, stop buttons, and emergency electrical stop switches on machinery
4. Location of first aid equipment
5. Traffic flow
6. Safety starter buttons
7. Exposed edges of pulleys, gears, rollers, cutting devices, power jaws
8. Fire protection equipment and apparatus
9. Dangerous parts of machines
10. Identification of starting point or power source of machinery

II. Describe the following classes of fires. (Three (3) points each)

11. Class A
12. Class B
13. Class C
14. Class D

III. Name the fire extinguisher(s) that should be used on the following classes of fires:

15. Class A
16. Class B
17. Class C
18. Class D

IV. List five (5) personal safety rules. (One (1) point each)

V. List ten (10) general shop safety rules. (One (1) point each)

VI. List 20 general welding safety precautions or rules. (One (1) point each)

VII. Outline the emergency evacuation procedure, as specified for your shop, in your school. Designate exits to be used, etc. (Three (3) points each)

Answer Key - Teacher Evaluation

Unit C: SAFETY

I. (Two (2) points for each correct answer; total 20 points)

1. Red
2. Yellow
3. Red
4. Green
5. Black and White
6. Orange
7. Orange
8. Red
9. Orange
10. Yellow

II. (Three (3) points for each correct answer; total of twelve (12) points)

11. Fires that occur in ordinary combustible materials (wood, rags, rubbish)
12. Fires that occur with flammable liquids (gasoline, oil, grease, paints, thinners)
13. Fires that occur in or near electrical equipment (motors, switchboards, electrical wiring)
14. Fires that occur with combustible metals such as magnesium

III. 15. Pressurized water
Soda acid
Foam
16. Carbon dioxide (CO_2)
Dry chemical
Foam
17. Carbon dioxide (CO_2)
Dry chemical
18. Dry chemical
Purple X

IV. Any five (5) of the following: (One (1) point each; total of five (5) points)

a. Wear shop clothing appropriate to the instructional activity being performed.
b. Confine long hair before operating rotating equipment.
c. Always wear safety glasses; use suitable helmets and goggles for welding.
d. Remove ties when working around machine tools or rotating equipment.

Unit C Answer Key (continued)

e. Remove rings and other jewelry when working in the shop.
f. Conduct yourself in a manner conducive to safe shop practices.
g. Use soap and water frequently as a method of preventing skin diseases

V. Any ten (10) of the following: (One (1) point each; total ten (10) points)

a. Keep all hand tools sharp, clean, and in safe working order.
b. Report any defective tools, machines, or other equipment to the instructor.
c. Operate a hazardous machine only after receiving instruction on how to operate the machine safely.
d. Retain all guards and safety devices except with the specific authorization of the instructor.
e. Report all accidents to the instructor regardless of nature or severity.
f. Turn off the power before leaving a machine tool.
g. Make sure all guards and barriers are in place and adjusted properly before starting a machine tool.
h. Disconnect the power from machine tools before performing the maintenance task of oiling or cleaning.
i. Use a solvent only after determining its properties, what kind of work if has to do, and how to use it.
j. Use correct, properly fitting wrenches for nuts, bolts, and objects to be turned or held.
k. Keep the shop or laboratory floor clear of scraps and litter.
l. Clean up any spilled liquids immediately.
m. Oily rags or oily waste should be stored in metal containers.
n. Clean the chips from a machine with a brush--not with a rag or the bare hands.

VI. Any 20 of the following: (One (1) point each; total 20 points)

a. Always wear suitable protective clothing.
b. Always keep a safe, clean work area.
c. Make sure there are no flammable materials near.
d. Do not weld in the vicinity of explosive materials or near carbon tetrachloride.
e. Always make sure you have enough ventilation to give three (3) or four (4) complete changes per hour.
f. Use air exhaust at the weld whenever welding lead, cadmium, chromium, manganese, brass, bronze, zinc, or galvanized metals.
g. Never weld or cut in a confined area without protection.
h. Handle inert gas cylinders with the same care you use with oxyacetylene cylinders.
i. Keep all welding equipment in good condition.

Unit C Answer Key (continued)

j. If it is necessary to couple lengths of cable together, make sure joints are insulated and all electrical connections are tight; use no cables with frayed, cracked, or bare spots.
k. When electrode holder is not in use, hang it on welding machine or special holder; never let it touch a gas cylinder.
l. Always have welding machine properly grounded.
m. Make sure pedal controls are guarded to prevent accidental starts.
n. If need arises to weld in damp or wet conditions, wear rubber boots and/or stand on dry cardboard or wood.
o. Stand only on solid items, floor, or ground.
p. When welding in high places without railings, use safety belt or lifeline.
q. Always wear proper eye protection, especially when grinding or cutting.
r. Keep booth curtains closed to protect the eyes of others.
s. Never weld or cut directly on a concrete floor.
t. When using a water-cooled torch, check for water leakage.
u. Do not use oil or grease on any oxygen or acetylene connections as oil and oxygen will ignite.
v. Never open tank valves until you are centain that regulator valves are closed.
w. Never open the valves on the cylinders with a hammer.
x. Never hammer on oxygen or acetylene regulators.
y. Do not light a torch with a match or open flame; use lighter provided.
z. Before lighting torch, be positive that hose, tanks, or any inflammable materials will not be exposed to heat, flame, or sparks.
aa. Beware of high acetylene pressure; never use acetylene gas when the pressure is greater than 15 pounds per square inch.
bb. Never screw the regulator screw in tight against the regulator as this spoils the diaphragm; if hose pressure drops, check tank pressure at regulator; tank is probably empty.
cc. Do not hold welding or cutting tip too close to your work; this will cause a flash-back in the torch.
dd. Never use a tip that gets hot.
ee. Never use a torch that leaks.
ff. Never leave your torch burning and go away from it.
gg. Never leave torch valve open.
hh. Do not use the torch for a hammer, crowbar, wedge, or for any other purpose than welding; do not use a cylinder, even when empty, as a roller.
ii. Do not store cylinders in a room where the temperature is more than 80° .
jj. Do not adjust, alter, change, build, or do any experimental work on cylinders, regulators, torches, or any other gas equipment.
kk. Never attempt to weld a closed or jacketed tank, vessel, or container without a vent for air.

Unit C Answer Key (continued)

VII. To be evaluated by the instructor. Should include outlined step-by-step procedure for evacuation, as it would be performed by the student; e.g., follow proper procedures to shut down equipment, remain calm, and orderly, etc.

Teacher Evaluation

Unit D: BASIC MATHEMATICS

A. Achievement Units in the text Basic Mathematics Simplified, as assigned at the end of each of the four Student Competency Sheets for this unit, may serve as pre-tests.

B. The four Achievement Review scores will constitute the Unit Test score if:

   1. The instructor does not wish to replace or supplement them with tests-on-hand, and

   2. The student has demonstrated at least 95% accuracy.

C. If supplementary work has been assigned to the student as a result of scores on the Achievement Reviews, or if the student has been assigned to a remedial math class, scores at the completion of the extra-work assignments or as supplied by the remedial math teacher will constitute the student's demonstration of the degree of competency attained.

Teacher Evaluation

Unit E: MEASURING

I. Print the common abbreviation for the following terms in the space provided. (One (1) point for each correct answer)

1. _____ Centimeter
2. _____ Quart
3. _____ Kilogram
4. _____ Decimeter
5. _____ Millimeter
6. _____ Square foot/feet
7. _____ Dekameter
8. _____ Yard
9. _____ Meter
10. _____ Hectometer

II. Match the standard English measure or the metric measurement to its decimal equivalent. Print the matching capital letter in the space provided. (Three (3) points for each correct answer)

11.	_____ One inch	A.	2.54 cm or 25.4 mm
12.	_____ One quart	B.	0.039"
13.	_____ One liter	C.	0.946 liters
14.	_____ One meter	D.	0.394"
15.	_____ One foot	E.	0.9144 m
16.	_____ One gallon	F.	0.6214 mi
17.	_____ One millimeter	G.	1.057 qts
18.	_____ One yard	H.	0.3048 m
19.	_____ One kilometer	I.	3.785 liters
20.	_____ One centimeter	J.	39.37"

Unit E Test (continued)

III. Match the terms with their definitions. Print the matching capital letter in the space provided. (One (1) point for each correct answer)

21.	_____	One or more parts of a whole.	A. Vertex
22.	_____	The smallest whole unit of linear measurement commonly used.	B. Inch
23.	_____	Surface or area between the center and a circumference.	C. Linear
24.	_____	The common starting point of lines on a circle.	D. Fraction
25.	_____	Measure of straight line distances between two (2) points, lines, or surfaces.	E. Sector
26.	_____	Amount of measure consisting of twelve (12) equal parts called inches.	F. Chord
			G. Foot
27.	_____	Straight line that extends inside a circle to join both ends of the arc.	H. Dimensions
28.	_____	The setting of limits or bounds according to a predetermined standard.	I. Measuring
29.	_____	One (1) of 60 equal parts of a degree.	J. Minute
30.	_____	The number of full units and fractions of units between two (2) points.	

IV. Complete the following statements. Print the answers. (One (1) point for each correct answer)

31. The three (3) steps for changing standard English (British) units of measure to metric units are:

a. _____

_____

Unit E Test (continued)

b. _____

_____

c. _____

_____

32. Where a rough direct line measurement within 1/16" is required, the dimension may be measured easily with a _____.

33. If a drawing shows a tolerance of plus or minus 1/32" or 1/64", a _____ is used for measuring lines.

34. The most commonly used unit of measure is the _____.

35. Two (2) ways of writing "one square foot" are:

a. _____

b. _____

36. If the outside of a cylinder were unrolled, it would form a _____.

37. Fractional parts of an inch are commonly expressed in the shop or the laboratory in _____.

V. Your instructor will provide you with pictures of two (2) objects (A and B). Select the correct measuring tool(s) for each. (40 points)

38. a. Measure Object A to 1/16" tolerance. (5 points)
b. Print the measured dimensions as they should appear on a drawing. (5 points)

39. a. Measure Object B to 1/16" tolerance. (5 points)
b. Print the measured dimensions as they should appear on a drawing. (5 points)
c. Convert the measurements to decimal equivalents. (10 points)
d. Convert the measurements to metric equivalents.

Answer Key - Teacher Evaluation

Unit E: MEASURING

I. (One (1) point each)

1. cm
2. qt.
3. kg
4. dm
5. mm
6. sq. ft.
7. dkm
8. yd.
9. m
10. hm

II. (Three (3) points each)

11. A
12. C
13. G
14. J
15. H
16. I
17. B
18. E
19. F
20. D

III. One (1) each)

21. D
22. B
23. E
24. A
25. C
26. G
27. F
28. I
29. J
30. H

IV. (One (1) point for each correct answer)

31. a. Determine the equivalent value of one (1) metric unit in the British system.
    b. Divide the given British unit by the metric equivalent of one (1) unit.
    c. Express the result in the required metric unit.

32. Ruler

33. Line-graduated steel rule

34. Inch

35. a. One (1) sq. ft. b. 1 □'

36. Rectangle

37. Decimal equivalents

V. To be evaluated by the instructor. (Total: 40 points)

38. a. Object measured to 1/16" tolerance (5 points)
    b. Dimensions printed accurately on drawing (5 points)

39. a. Object measured to 1/16" tolerance (5 points)
    b. Dimensions printed accurately on drawing (5 points)
    c. Measurements correctly converted to decimal equivalents (10 points)
    d. Measurements correctly converted to metric equivalents (10 points)

Teacher Evaluation

TASK TEST

Unit F: READING BLUEPRINTS Task 1: Identify Basic Print Information

1. An orthographic projection is a drawing method which shows: _____

_____.

2. A note is: _____

_____.

3. The functions of dimensions on a print are:

a. _____

b. _____

4. Which of the following are included on a blueprint specification? Check (✓) all that apply.

a. _____ Quantity required	g. _____ Welding process
b. _____ Name of part	h. _____ Drawn by
c. _____ Date	i. _____ Dimension
d. _____ Order number	j. _____ Scale size used
e. _____ Symbol	k. _____ Number of the drawing
f. _____ Material	l. _____ Gage number

5. Draw each of the following lines:

a. Border line

b. Object line

c. Hidden line

d. Extension line

e. Dimension line

f. Center line

g. Leader line

Unit F-1 TASK TEST (continued)

h. Cutting plane line

i. Short break line

j. Long break line

Answer Key - Teacher Evaluation

Unit F: READING BLUEPRINTS Task 1: Identify Basic Print Information

Questions 1, 2, 3a, 3b-- six (6) points for each correct answer.

1. The exact form of an object by various views of the object arranged in a particular order.

2. Lettered identification concerning the details of construction. It specifies, explains, or refers to material and/or process needed to make the part.

3. a. Give sizes needed to fabricate the part.
   b. Indicate locations where components of the part should be placed or machined.

4. a. X
   b. X
   c. X
   d. X
   e. (no)
   f. X
   g. (no)
   h. X
   i. (no)
   j. X
   k. X
   l. (no)

5. Six (6) points for each accurate line representation.

Teacher Evaluation

TASK TEST

Unit F: READING BLUEPRINTS Task 2: Identify Metal Shapes, Views, and Sections

I. Matching:

Which gage is most commonly used to designate the thickness of the following structural metals? (Place the correct letter--a, b, or c--next to the corresponding metal shape.)

1. _____ Brass sheets
2. _____ Sheet copper
3. _____ Steel plate
4. _____ Aluminum
5. _____ Steel bands
6. _____ German silver
7. _____ Crucible spring sheet steel
8. _____ Iron sheets
9. _____ Strip Steel
10. _____ Steel sheets

a. U.S. Standard Sheet Metal Gauge

b. Brown and Sharpe Wire Gauge or American (AWG)

c. Birmingham Wire Gauge

II. Complete the Statement:

11. Sheet metal is _____ in thickness.
12. Metal plate is _____ in thickness.
13. A structural shape expressed as 4" x 2" x 1/2" -18' is a _____.
14. A structural shape expressed as 5" H 10 16' long is a _____.
15. A structural shape expressed as 1/4" x 6" is a _____.
16. An imagined view of an object cut entirely in half is a _____.

Unit F-2 TASK TEST (continued)

17. An imagined view of an object cut only half way through is a _____.

18. A _____ represents interior details of assembled parts.

19. The distinguishing characteristics of hot-rolled metal are:

_____

20. The distinguishing characteristics of cold-rolled metal are:

_____

III. Multiple Choice: (Circle the correct answer)

21. In what order are the measurements of sheet and plate specified?

a. Length, width, thickness

b. Width, length, thickness

c. Thickness, width, length

d. Thickness, length, width

22. Weight specifications are not applied to which of the following:

a. Pipe

b. I-beams

c. H-beams

d. W.F.-beams

23. A revolved section is a cross section which has been turned:

a. 180°

b. 90°

c. 45°

d. 360°

67

Unit F-2 TASK TEST (continued)

24. An auxiliary view shows:

    a. Back of the surface

    b. Plane of the slanted surface

    c. Bottom of the surface

    d. Right-side of the surface

25. Dimensions shown on the developed view include:

    a. Break symbols

    b. Multiple auxiliary views

    c. No allowance for bending or rolling

    d. Allowances necessary for bending or rolling

Answer Key - Teacher Evaluation

Unit F: READING BLUEPRINTS Task 2: Identify Metal Shapes, Views, and Sections

I. (Four (4) points for each correct answer)

1. b
2. c
3. a
4. b
5. c
6. b
7. c
8. a
9. c
10. a

II. (Five (5) points for each correct answer)

11. 3/16" or less
12. Greater than 3/16"
13. Tee bar
14. H-beam
15. Flat bar
16. Full section
17. Half section
18. Assembly section
19. Slightly oversized and round corners
20. Precise in size and square corners

III. (Two (2) points for each correct answer)

21. c
22. a
23. b
24. b
25. d

Teacher Evaluation

TASK TEST

Unit F: READING BLUEPRINTS Task 3: Interpret Welding Abbreviations and Symbols

I. Matching. Select the lettered item which matches the abbreviations-Print the letter of the correct word(s) answer in the space next to abbreviation.

1.	_____ GI	A.	Thread
2.	_____ OD	B.	Pitch
3.	_____ Std	C.	Chamfer
4.	_____ csk	D.	Gage
5.	_____ CW	E.	Outside diameter
6.	_____ thd	F.	Galvanized iron
7.	_____ FW	G.	Standard
8.	_____ ID	H.	Countersink
9.	_____ OAW	I.	Brass, SAE #
10.	_____ RW	J.	Inside diameter
11.	_____ Chfr	K.	Roll welding
12.	_____ SMAW	L.	Shielded Metal-Arc Welding
13.	_____ Ga	M.	Cold welding
14.	_____ ME	N.	Oxyacetylene welding
15.	_____ FLB	O.	Manual
16.	_____ P	P.	Flux cored arc welding
17.	_____ br #	Q.	Carbon arc welding
18.	_____ MA	R.	Flow brazing
19.	_____ CAC	S.	Flash welding
20.	_____ FCAW	T.	Machine

Unit F-3 TASK TEST (continued)

II. Multiple Choice. (Circle the correct answer)

21. The arrows of the welding symbols point to:

    a. Surface

    b. Welding process

    c. Dimension lines

    d. Increments

22. Welds that appear directly opposite each other on the two (2) sides of the joint are:

    a. Continuous welds

    b. Chain intermittent welds

    c. Staggered intermittent welds

    d. Extended welds

23. Only one of the two (2) members is chamfered or grooved in the:

    a. Square-groove weld

    b. J-groove weld

    c. Flare V-groove weld

    d. U-groove weld

24. The slot welding symbol shows:

    a. Surface contour and finishing

    b. Depth of filling, pitch, contour, size

    c. Depth of filling, surface contour, finishing

    d. Size, angle of countersink, depth of filling, pitch, contour, finishing information

25. Which of the following would not be applied to the seam weld symbol:

    a. Size

    b. Length of weld

    c. Number of welds

    d. Strength

Unit F-3 TASK TEST (continued)

III. Completion. Print the correct answer in the space provided in the left-hand column.

26. _____ If the length of the weld is specified, it is placed to the immediate ___?___ of the weld symbol.

27. _____ The degree of fusion which the weld makes with the members being welded is called ___?___.

28. _____ The distance between the members at the bottom of the weld is called ___?___.

29. _____ When the angle formed by the members to be welded is given, it is placed ___?___ the weld symbol.

30. _____ A back weld is distinguished from a back-up weld only by ___?___ with respect to the groove weld.

31. _____ A ___?___ weld can be applied to either a flat or contoured surface.

32. _____ A ___?___ weld is used for joining light-gage metal pieces.

33. _____ The size of a spot weld is shown ___?___ of the weld symbol.

34. _____ The spacing of spot welds in indicated by a number placed ___?___ of the weld symbol.

35. _____ A projection weld is a resistance-type weld which is generally applied to ___?___.

Answer Key - Teacher Evaluation

Unit F: READING BLUEPRINTS Task 3: Interpret Welding Abbreviations and Symbols

I. Matching. (Two (2) points for each correct answer)

1. F
2. E
3. G
4. H
5. M
6. A
7. S
8. J
9. N
10. K
11. C
12. L
13. D
14. T
15. R
16. B
17. I
18. O
19. Q
20. P

II. Multiple Choice. (Two (2) points for each correct answer)

21. c
22. b
23. b
24. c
25. c

III. Completion. (Five (5) points for each correct answer)

26. Right
27. Penetration
28. Root opening
29. Inside
30. Sequence of application
31. Surface
32. Flange
33. Left
34. Right
35. Lap or edge joint

Teacher Evaluation

Unit F: READING BLUEPRINTS

PRINT ALL ANSWERS

I. Sketch the preferred weld symbols for each of the following:

1. Surface weld

2. V-groove

3. Plug weld

4. Slot weld

5. Bevel groove

II. Match the elements which may be applied to each given type of weld:

6. Fillet weld

_____

7. Groove weld

_____

a. Size
b. Length
c. Strength
d. Included angle
e. Pitch
f. Increments
g. Side of joint
h. Extent of welding
i. Contour
j. Method of finish
k. Field weld

III. Your instructor will provide a drawing. Refer to the drawing and answer the following questions:

8. What is the scale size used? _____

9. List any item classified as a specification. _____

_____

_____

Unit F Test (continued)

10. Name the principle views used to show the object. _____

_____

_____

11. Why is this particular arrangement used? _____

_____

_____

12. List the structural metal shapes required for making the object.

_____

_____

_____

13. Are any break lines used on the principal views? _____

If so, why are they used? _____

_____

_____

14. Sketch the kinds of breaks that are used. Name them.

15. Sketch the different welding symbols shown on the print. Name them and give the significance of each.

Unit F Test (continued)

16. Are there any drilled holes? _____

    If so, what are the location dimensions? _____

    _____

    _____

17. List the types of lines found on the print. _____

    _____

    _____

18. Give the sizes and number of fittings used. _____

    _____

    _____

19. What types of welds are specified? (Draw the symbol and print the name and significance of each.)

Answer Key - Teacher Evaluation

Unit F: READING BLUEPRINTS

ALL ANSWERS MUST BE PRINTED LEGIBLY

I. (Evaluated by teacher)
Two (2) points for each correct drawing; total of ten (10) points.

II. One (1) point for each correct answer; total of 15 points.

6. a
b
e
f
g
h
i
j
k

7. a
d
g
i
j
k

III. The instructor will supply a drawing of an object which will later be fabricated in the class. Review the drawing in reference to the items on the student test. Evaluate student answers.

8. Three (3) points for correct reading

9. Three (3) points for correct reading

10. Five (5) points for correct reading

11. Five (5) points for correct reading

12. Five (5) points for correct reading

13. Five (5) points for correct reading

14. Ten (10) points for correct identification and labeling

15. Ten (10) points for correct identification and labeling

16. Five (5) points for correct reading and dimensions

Unit F Answer Key (continued)

17. Four (4) points for correct identification

18. Five (5) points for correct identification

19. 15 points for correct identification, drawing, and labeling

Teacher Evaluation

MODULE TEST

Unit I: OPERATING SHIELDED METALLIC ARC WELDING EQUIPMENT
Module A: Equipment Set-up

1. Name the common equipment needed in shielded metal arc welding:

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

   i.

   j.

   k.

2. Check the statement that signifies reverse polarity:

   _____ a. Current flows from electrode to base metal

   _____ b. Current flows from base metal to electrode

3. Check the statement that determines polarity:

   _____ a. Type of flux on electrode

   _____ b. Electrode

   _____ c. Current

   _____ d. Brand of welding machine

4. Name the two (2) types of operating adjustments found on arc welding machines:

   a.

   b.

Answer Key - Teacher Evaluation

MODULE TEST

Unit I: OPERATING SHIELDED METALLIC ARC WELDING EQUIPMENT
Module A: Equipment Set-up

1. a. Welding machine
   b. Electrode holder with lead
   c. Ground clamp with lead
   d. Shield or helmet
   e. Gloves
   f. Chipping hammer
   g. Safety goggles
   h. Wire brush
   i. Electrodes
   j. Pliers
   k. Protective clothing
2. b. (Current flows from base metal to electrode)
3. a. (Type of flux on electrode)
   b. (Electrode)
4. a. Current
   b. Polarity

Teacher Evaluation

TASK TEST

Unit I: OPERATING SHIELDED METALLIC ARC WELDING EQUIPMENT
Task 1: Set Up Machine for Current Requirements

I. Safety Quiz. Answer each by circling "T" for true, or "F" for false.

T F 1. You should warn anyone nearby before you start to weld.

T F 2. Goggles as well as a welding hood should be available before you start to weld.

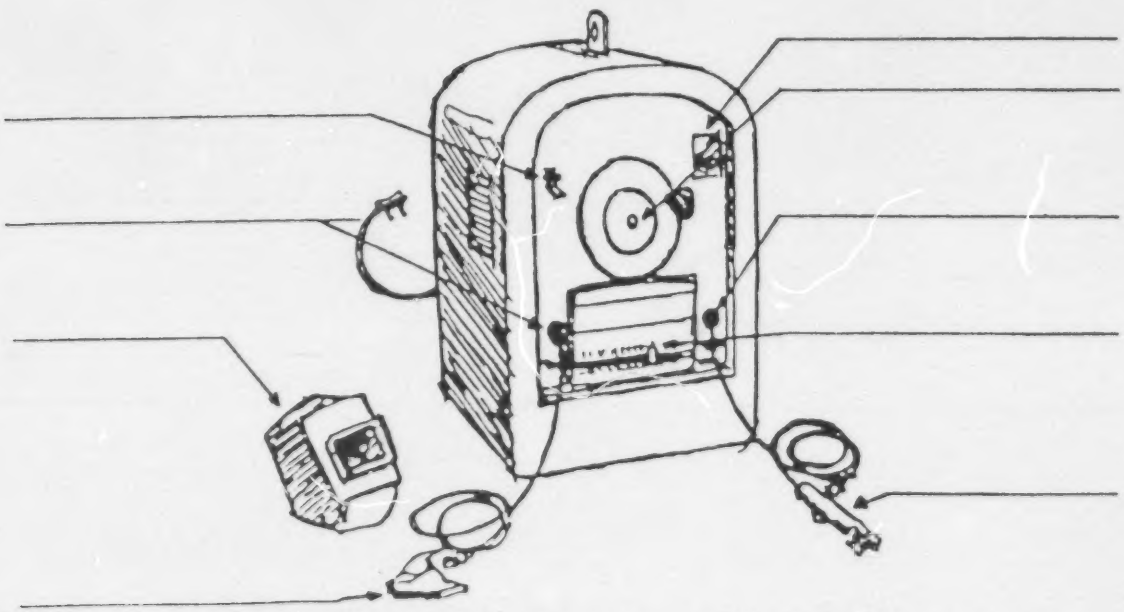
T F 3. A closed container is dangerous to weld.

T F 4. Gloves are not necessary when welding.

T F 5. It is dangerous to weld without proper ventilation.

T F 6. An electric shock is possible if both the electrode and ground are contacted.

II. Print the correct names:



Reprinted from: Pennsylvania Industrial Arts Safety Guide, Pennsylvania Department of Education, Industrial Arts Association of Pennsylvania, 1978.

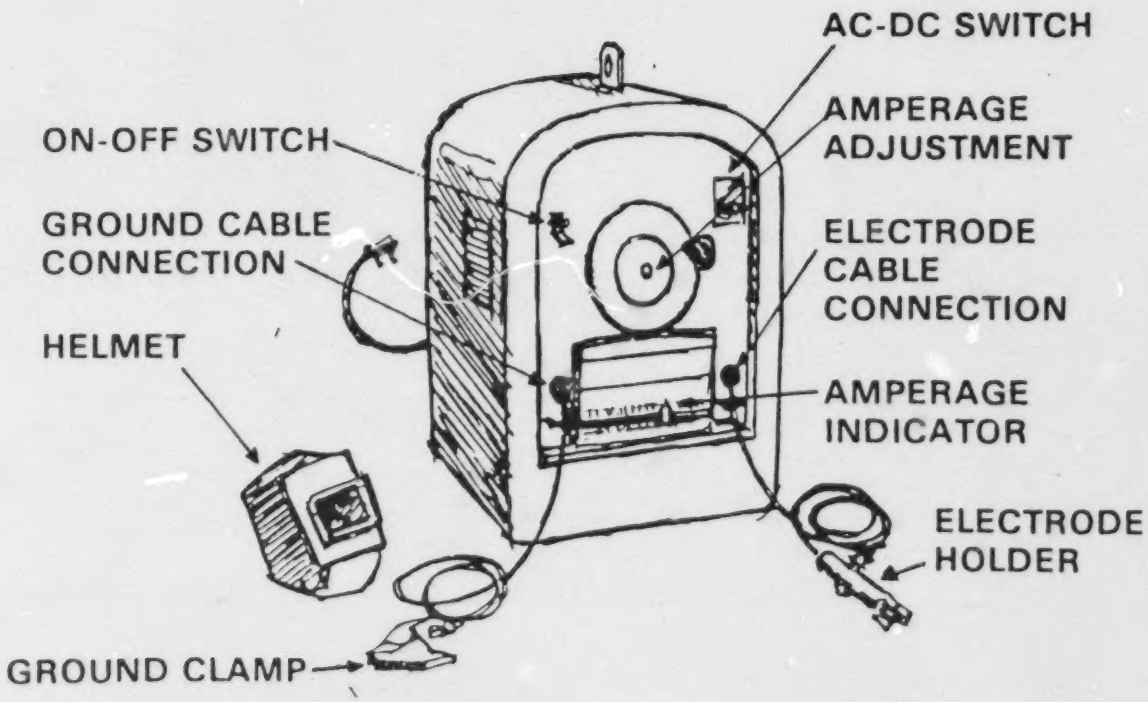
Answer Key - Teacher Evaluation

TASK TEST

Unit I: OPERATING SHIELDED METALLIC ARC WELDING EQUIPMENT
Task 1: Set Up Machine for Current Requirements

I. 1. T
2. T
3. T
4. F
5. T
6. T

II.



Teacher Evaluation

MODULE TEST

Unit I: OPERATING SHIELDED METALLIC ARC WELDING EQUIPMENT
Module B: Welding

1. Name four (4) types of welds.

   a.

   b.

   c.

   d.

2. Check any of the following statements that contribute to reasons for poor welds?

   _____ a. Improper angle of electrode

   _____ b. Improper electrode and size

   _____ c. Improper machine adjustment

   _____ d. Improper clamping of electrode in holder

   _____ e. Welding from left to right with the forehand technique

   _____ f. Improper base metal preparation

   _____ g. Running a E-6010 electrode on DCRP

   _____ h. Improper arc length

3. List the two (2) methods of striking an arc:

   a.

   b.

4. List five (5) safety precautions to follow in shielded metal arc welding:

   a.

   b.

   c.

   d.

   e.

Unit I-B MODULE TEST (continued)

5. Perform the following operations:

   a. Start, stop, and restart a bead.

   b. Strike an arc and construct a pad in flat position, using E-6010 rod, by running uniform beads on mild steel plate which is 1/4" to 3/8 " thick.

   c. Construct a square groove butt weld on 3/16" to 1/4" steel plate with 100% penetration, using a single pass with E-6010 rod.

(NOTE: If any activities covered in this test have not been accomplished in this module of instruction, ask the instructor when they should be completed.)

Answer Key - Teacher Evaluation

MODULE TEST

Unit I: OPERATING SHIELDED METALLIC ARC WELDING EQUIPMENT
Module B: Welding

1. a. Bead
   b. Fillet
   c. Groove
   d. Plug

2. a
   b
   c
   f
   h

3. a. Tapping
   b. Scratching

4. Any five (5):

   a. Keep equipment in good, clean, dry condition.
   b. Make sure all electrical connections are tight, clean, and dry.
   c. Use correct size welding cable. Do not overload.
   d. Be sure cables, holder, and connections are properly insulated.
   e. Cut off power to welder before cleaning machine or making internal adjustments.
   f. Never change polarity or current settings while machine is under load.
   g. Observe normal operating care for electrical hazards.
   h. Keep work area neat, clean, and dry.
   i. Remove flammable materials from welding area, or shield them.
   j. Do not weld near volatile, flammable liquids, or gases.
   k. Do not weld or cut on containers such as drums, barrels, or tanks until you know there is no danger of fire or explosion.
   l. Dispose of hot electrode stubs in a metal container.
   m. Never strike an arc on a compressed gas cylinder.
   n. Protect eyes from rays of the arc: wear a headshield with the proper filter plates when welding or cutting.
   o. Wear protective chipping goggles when chipping off weld slag.
   p. Wear leather gloves and protective clothing such as an apron, sleeves, etc., to shield against the arc rays and sparks; button up shirt collar.
   q. Use a non-reflecting welding curtain to protect others in the area from the arc rays.
   r. Be sure work area has adequate ventilation--plenty of fresh air. Special precautions are necessary when welding lead, zinc, beryllium copper, or cadmium.
   s. Do not pick up hot metal.

Unit I-B Answer Key (continued)

t. Always open main switch or disconnect plug when checking over a welder.
u. Do not leave electrode holder on welding table or in contact with grounded metal surface.
v. Keep tools and metal in their proper locations.

5. The student's performance will be evaluated by the instructor.

Teacher Evaluation

Unit I: OPERATING SHIELDED METALLIC ARC WELDING EQUIPMENT

I. Shielded Metal Arc Welding

1. Match the following terms with the correct definition.

(1) Whipping	(11) Tack weld
(2) Shielded metal arc welding	(12) Crater
(3) Weld metal	(13) Spatter
(4) Arc	(14) Face of weld
(5) Weaving	(15) Porosity
(6) Electrodes	(16) Flux
(7) Undercut	(17) Pass
(8) Base metal	(18) Low carbon steel
(9) Puddle	(19) AWS
(10) Arc length	(20) Disposition rate

_____ a. The exposed surface of a weld, made by an arc or gas welding process on the side from which welding was done.

_____ b. An arc welding process wherein metals are united by heating with an electric arc between a coated metal electrode and the metal.

_____ c. A depression at the termination of a weld.

_____ d. The flow of electric current from the tip of the electrode to the base of the metal being welded.

_____ e. The distance from the end of the electrode to the point where the arc makes contact with work surface.

_____ f. Metal rods which conduct a current from the electrode holder to the base metal.

_____ g. The metal to be welded or cut.

_____ h. A fusible material or gas used to dissolve and/or prevent the formation of oxides, nitrides, or other undesirable inclusions formed in welding.

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Unit I Test (continued)

_____ i. That portion of a weld that is molten at the place the heat is supplied.

_____ j. A weld made to hold parts in proper alignment until the final welds are made.

_____ k. Steel containing .20% or less carbon.

_____ l. The metal particles given off during welding which do not form a part of the weld.

_____ m. A single longitudinal progression of a welding operation along a joint or weld deposit.

_____ n. Gas pockets or voids in metal.

_____ o. A term applied to an inward and upward movement of the electrode which is employed in vertical welding to avoid undercut.

_____ p. A groove melted into the base metal adjacent to the toe of the weld and left unfilled by weld metal.

_____ q. That portion of a weld which has been melted during welding.

_____ r. A technique of depositing weld metal in which the electrode is oscillated.

_____ s. American Welding Society.

_____ t. Amount of filler metal deposited in any welding process; rate is in pounds per hour.

2. Name four (4) types of arc welding machines.

   a.

   b.

   c.

   d.

3. Discuss in a short paragraph the procedures to follow in testing for polarity.

Unit I Test (continued)

4. Name four (4) common types of electrodes.

   a.

   b.

   c.

   d.

5. Name four (4) common sizes of electrodes.

   a.

   b.

   c.

   d.

6. Check the statement which determines how electrode size is selected.

   _____ a. Length of electrode

   _____ b. Bare end of electrode

   _____ c. Type of flux on electrode

7. Place an "X" in the blank by the statements which identifies the purposes of flux on electrodes.

   _____ a. Stabilizes arc

   _____ b. Makes arc starting difficult

   _____ c. Shields molten puddle from air

   _____ d. Provides deoxidizers and scavengers to prevent porosity of weld zone

   _____ e. Keeps moisture out of filler metal

   _____ f. Forms slag and slows cooling

Unit I Test (continued)

8. Name five (5) factors to be considered when selecting an electrode

   a.

   b.

   c.

   d.

   e.

9. Identify the parts of groove and fillet welds in the drawings below.

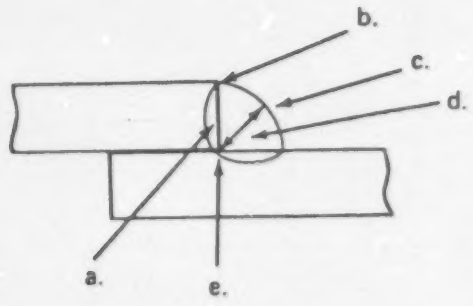
   a.

   b.

   c.

   d.

   e.



   f. Type of weld

   g.

   h.

   i.

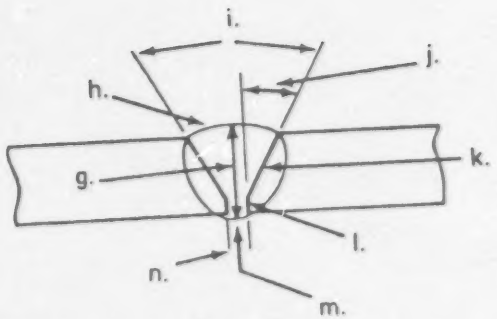
   j.

   k.

   l.

   m.

   n.



   o. Type of weld

Unit I Test (continued)

10. Match the lens shade number on the right to the type of welding operation. Some of the numbers may be used more than once.

_____	a. Gas welding using metal 0 - 1/8 inch thick	1. No. 2
_____	b. Soldering	2. No. 3 or 4
_____	c. Torch brazing	3. No. 4 or 5
_____	d. Shielded metal arc welding using 1/16, 3/32, 1/8, and 5/32 inch electrodes	4. No. 5 or 6
_____	e. Gas tungsten arc welding non-ferrous	5. No. 6 or 8
_____	f. Oxygen cutting using metal six (6) inches and over	6. No. 9 - 14

II. SMAW--Position Welding

1. Match the following terms with the correct definition.

(1) Root	(10) String bead
(2) Pad	(11) Horizontal position
(3) Undercutting	(12) Weld face
(4) Arc blow	(13) Cold lap
(5) Penetration	(14) Slag inclusion
(6) Vertical position	(15) Coupon
(7) Porosity	(16) Crater
(8) Root opening	(17) Overhead position
(9) Fusion	

_____ a. The portion of the crater left unfilled due to excessive current and the improper movement of the electrode occuring at the edge of the bead.

_____ b. That portion of a weld which is removed from the test plate to test for strength.

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Unit I Test (continued)

_____ c. The exposed surface of a fusion weld.

_____ d. The distance from the original surface of the base metal to that point at which fusion ceases.

_____ e. A series of overlapping stringer beads that completely cover the surface of a practice plate increasing its thickness by each subsequent layer.

_____ f. The running of a horizontal bead on a vertical surface.

_____ g. A concentration of magnetic force acting on the welding arc causing it to deflect, move, or "blow" from its normal path.

_____ h. The bottom surface of a weld on the opposite side from which welding was done.

_____ i. A piling up of weld metal due to improper starts and current adjustments causing a defect usually at the start of the weld.

_____ j. Non-metallic porous material entrapped in weld metal or between the weld metal and base metal.

_____ k. The beads are deposited in a vertical position on a vertical surface; axis of weld is vertical.

_____ l. A weld bead made with very little rod manipulation.

_____ m. A condition caused by a trapped gas pocket in a gas pocket in a gas pocket in a weld as it solidifies.

_____ n. The melting of metals until the molten portions unite with each other.

_____ o. The gap between members to be joined at the root of the joint.

_____ p. A depression in the face of a weld caused by arc force; usually found at the end of a bead.

_____ q. The position of welding wherein welding is performed from the underside of the joint.

Unit I Test (continued)

2. Name four (4) factors that determine proper machine adjustment.

   a.

   b.

   c.

   d.

3. Name the four (4) welding positions.

   a.

   b.

   c.

   d.

4. Check each of the reasons for removing slag from a weld.

   _____ a. Prevents better fusion of beads

   _____ b. Prevents penetration

   _____ c. Prevents gas pockets and slag inclusions from forming in bead

   _____ d. Improves appearance of bead

   _____ e. Causes irregular arc

5. List three (3) reasons for fusing one (1) bead in with another.

   a.

   b.

   c.

6. List four (4) factors that determine weld quality.

   a.

   b.

   c.

   d.

Unit I Test (continued)

7. Name two (2) causes and two (2) solutions to prevent arc blow.

   a. Causes

      (1)

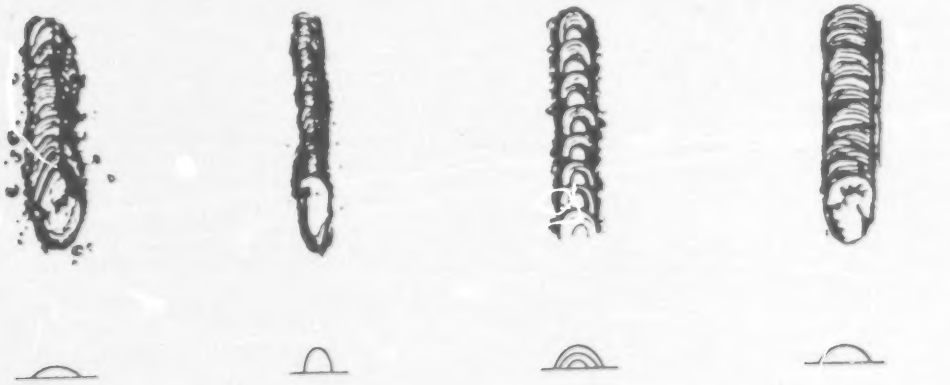
      (2)

   b. Solutions

      (1)

      (2)

8. Identify the following examples of properly and improperly formed beads by telling what caused each one.



a. _____ b. _____ c. _____ d. _____

e. _____ f. _____ g. _____

Answer Key - Teacher Evaluation

Unit I: OPERATING SHIELDED METALLIC ARC WELDING EQUIPMENT

I. Shielded Metal Arc Welding

1. Match terms with definitions.

a. 14	f. 6	k. 18	p. 7
b. 2	g. 8	l. 13	q. 3
c. 12	h. 16	m. 17	r. 5
d. 4	i. 9	n. 15	s. 19
e. 10	j. 11	o. 1	t. 20

2. a. AC
   b. AC-DC
   c. Motor generator--Produces DC current
   d. Engine generator--Produces DC current

3. The discussion should bring out the two (2) main methods.

   a. Weld a bead using E-6010 reverse polarity electrode.
   b. Strike arc with carbon electrode.

4. Any four (4) of the following:

   a. Mild steel
   b. Low hydrogen--low alloy
   c. Non-ferrous
   d. Hard surfacing
   e. Cast iron
   f. Stainless steel

5. Any four (4) of the following:

   a. 3/32"
   b. 1/8"
   c. 5/32"
   d. 3/16"
   e. 7/32"
   f. 1/4"
   g. 5/16"

6. b

7. a
   c
   d
   f

8. Any five (5) of the following:

   a. Base metal strength properties
   b. Base metal composition
   c. Welding position
   d. Welding current
   e. Joint design and fit-up
   f. Thickness and shape of base metal
   g. Service conditions and/or specification
   h. Production efficiency and job conditions

Unit I Answer Key (continued)

9.

a.	Leg	f.	Fillet	k.	Groove face
b.	Toe	g.	Throat	l.	Root face
c.	Face	h.	Face	m.	Root
d.	Throat	i.	Groove angle	n.	Root opening
e.	Root	j.	Bevel angle	o.	Groove

10.
a. 3
b. 1
c. 2
d. 6
e. 6
f. 4

II. SMAW--Position Welding

1.

a.	3	e.	2	i.	13	m.	7
b.	15	f.	11	j.	14	n.	9
c.	12	g.	4	k.	6	o.	8
d.	5	h.	1	l.	10	p.	16
						q.	17

2. Any four (4) of the following:

a. Thickness of base metal
b. Diameter and type of electrode
c. Welding position
d. Welding technique used by operator
e. Length of welding cables
f. Efficiency of welding machine and polarity

3.
a. Flat
b. Vertical
c. Horizontal
d. Overhead

4.
c
d

5.
a. Increases strength of weld
b. Improves appearance of bead
c. Improves penetration

6.
a. Amperage
b. Length of arc
c. Speed of travel
d. Position of electrode

Unit I Answer Key (continued)

7. a. Causes

(1) Magnetic forces present with DC current build up lines of magnetism around the arc causing it to be unstable with excessive spatter.
(2) High amperage, thick plates, corners, deep grooves, and the start and finish of joints are the major problem areas.

Any two (2) of the following:

b. Solutions

(1) Reduce current or switch polarity.
(2) Change current to AC.
(3) Change location of ground clamp.
(4) Wrap ground cable around work piece and pass ground current through it to neutralize magnetic field.
(5) Maintain a short arc.

8. a. Current high
b. Current low
c. Speed fast
d. Current, voltage, and speed normal
e. Voltage high
f. Voltage low
g. Speed slow

III. Performance

Practice exercises performed from the job sheets will be evaluated by the instructor.

Teacher Evaluation

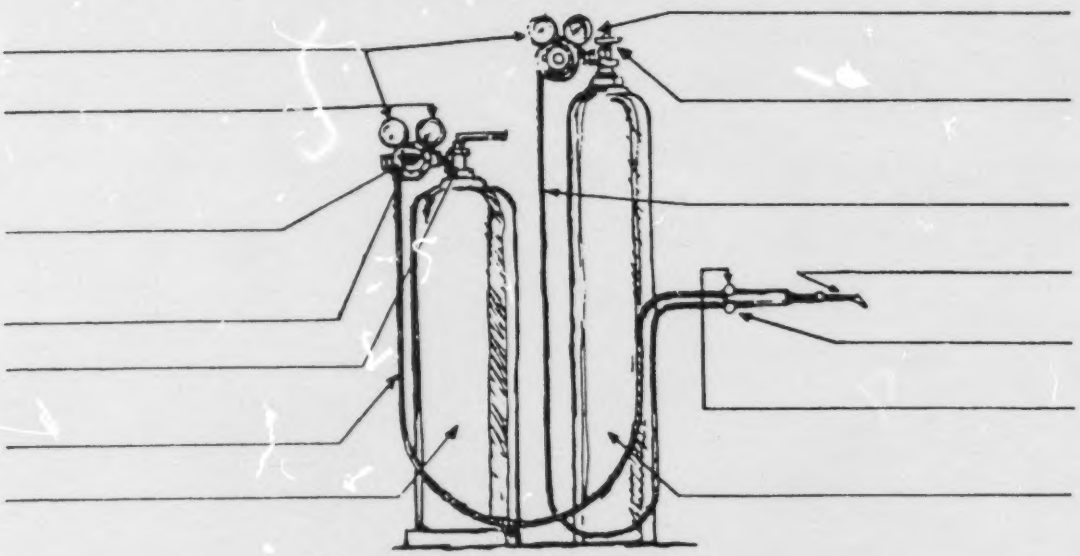
TASK TEST

Unit II: OPERATING GAS WELDING EQUIPMENT
Task 1: Set Up Portable or Stationary Oxy-Fuel Equipment

I.

1. List ten (10) safety practices.
2. List procedure for set-up of oxy-fuel system.
3. List shut-down procedure for oxy-fuel system.

II. Identify all major components on the drawing of an oxy-fuel system. (Time: 15 minutes)



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Answer Key: The student's performance will be evaluated by the instructor.

Teacher Evaluation

TASK TEST

Unit II: OPERATING GAS WELDING EQUIPMENT
Task 2: Change Oxygen, Acetylene, or MAPP Gas (Methyl-Acetylene Propadiene) Cylinders

I. List ten (10) safety practices to follow when changing cylinders.

II. 1. Write the procedure for changing the oxygen cylinders.

2. Write the procedure for changing the acetylene cylinders.

3. Write the procedure for changing the methyl-acetylene propadiene (MAPP gas) cylinders.

Answer Key: The student's performance will be evaluated by the instructor.

Teacher Evaluation

TASK TEST

Unit II: OPERATING GAS WELDING EQUIPMENT
Task 1: Cut Carbon Steels with Oxy-Acetylene Equipment

I. Write the procedure for setting up oxy-fuel system for cutting.

Answer Key: The student's performance will be evaluated by the instructor.

Teacher Evaluation

MODULE TEST

Unit II: OPERATING GAS WELDING EQUIPMENT
Module B: Cutting and Shaping Materials

Perform the following operations:

1. Set up equipment for oxy-acetylene cutting.

2. Turn on, light, and adjust to a neutral flame and turn off the oxy-acetylene cutting equipment.

3. Using a straightedge and soapstone, lay out a pattern on metal.

4. Make 90° cuts on mild steel and restart a cut.

5. Make a flame-beveled cut on mild steel plate.

6. Cut a hole in mild steel.

(NOTE: If any activities covered in this test have not been accomplished in this module of instruction, ask the instructor when they should be completed.)

Answer Key: The student's performance will be evaluated by the instructor.

Teacher Evaluation

MODULE TEST

Unit II: OPERATING GAS WELDING EQUIPMENT
Module C: Brazing and Soldering Operations

Demonstrate the ability to braze weld a square groove butt joint--11ga.

Answer Key: The student's performance will be evaluated by the instructor.

Teacher Evaluation

MODULE TEST

Unit II: OPERATING GAS WELDING EQUIPMENT
Module D: Welding and Braze Welding

Perform the following operations:

1. Set up equipment for oxy-acetylene welding.
2. Turn on, light, adjust and turn off the oxy-acetylene welding equipment.
3. Construct a corner weld without filler rod.
4. Lay beads on gauge metal with and without filler rod.
5. Weld butt joints with filler rod.

(NOTE: If any activities covered in this test have not been accomplished in this module of instruction, ask the instructor when they should be completed.)

Answer Key: The student's performance will be evaluated by the instructor.

Teacher Evaluation

Unit II: OPERATING GAS WELDING EQUIPMENT

I. Oxy-acetylene Braze Welding

1. Define the following terms:

   a. Flux

   b. Ductile

   c. Malleability

   d. Braze welding

   e. Tinning operation

2. Explain the differences between brazing and braze welding procedures.

3. List three (3) advantages of braze welding.

   a.

   b.

   c.

4. List three (3) disadvantages of braze welding.

   a.

   b.

   c.

5. List four (4) characteristics of the elements found in the filler rods used in braze welding.

   a.

   b.

   c.

   d.

Unit II Test (continued)

6. What is the importance of having a clean metal surface in braze welding?

7. Write the procedures for removing oxides from a clean metal surface.

   a.

   b.

8. The five (5) purposes of flux are:

   a.

   b.

   c.

   d.

   e.

9. Name the color of the base metal when the proper temperature is obtained in braze welding.

10. Describe the reaction of the molten bronze when the temperature of the base metal is:

    a. Medium (dull red color)

    b. Too hot

    c. Not hot enough

Unit II Test (continued)

II. Oxy-acetylene Cutting

1. Define the following terms.

   a. Flashback

   b. Backfire

   c. Flame cutting

   d. Slag box

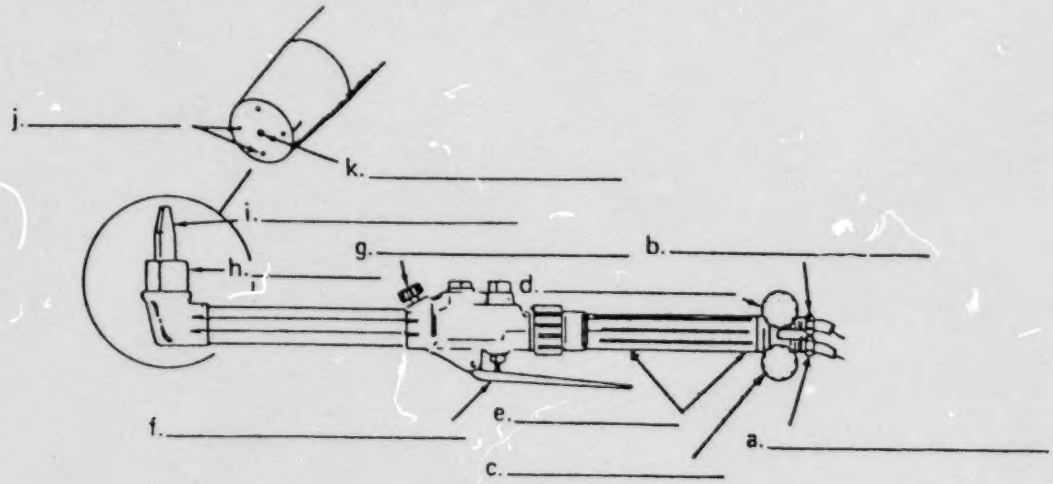
   e. Drag line

   f. Kerf

   g. Oxide

   h. Oxidizing

2. Identify the parts of the torch body and cutting attachment.



3. List the purposes of a slag box.

   a.

   b.

   c.

   d.

Unit II Test (continued)

4. List five (5) reasons for poor cuts.

   a.

   b.

   c.

   d.

   e.

5. List four (4) causes of a backfire.

   a.

   b.

   c.

   d.

6. Describe the results when a backfire takes place.

7. Describe the results when a flashback takes place.

8. List in the proper order the steps to follow in case of a flashback.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

Unit II Test (continued)

III. Oxy-acetylene Fusion Welding

1. Define the following terms.

   A. Tack weld

   B. Fusion welding

   C. Base metal

   D. Penetration

   E. Alloy

   F. Inner cone

2. List ten (10) safety rules for handling oxygen, acetylene, and oxy-acetylene welding equipment.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

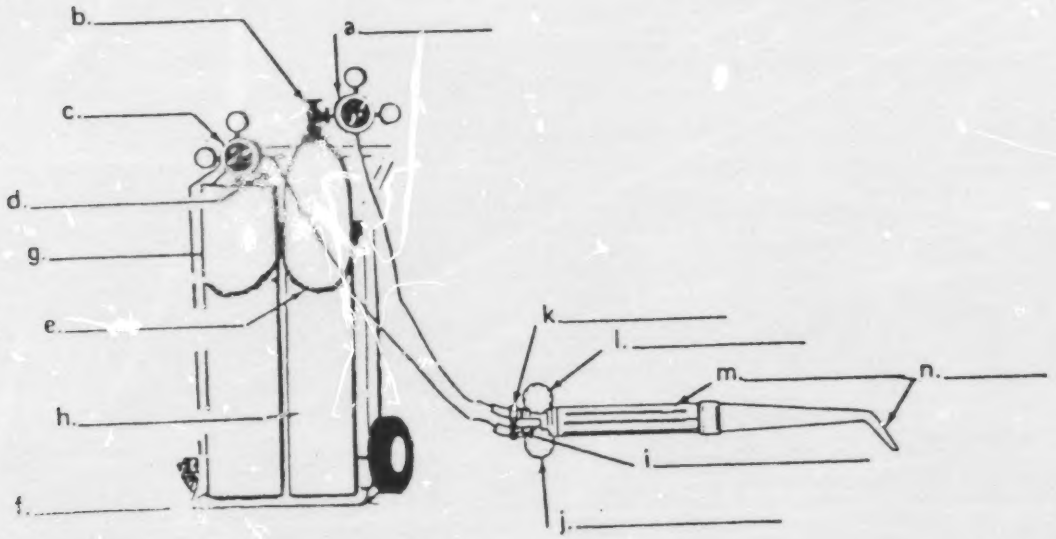
   h.

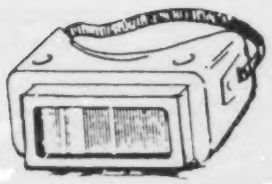
   i.

   j.

Unit II Test (continued)

3. Identify the following oxy-acetylene fusion welding equipment.





o._____

p._____

q._____

Unit II Test (continued)

4. Name five (5) factors that determine fusion weld quality.

   a.

   b.

   c.

   d.

   e.

5. List five (5) properties of a good weld.

   a.

   b.

   c.

   d.

   e.

6. Name two (2) factors that determine tip size in oxy-acetylene fusion welding.

   a.

   b.

7. List two (2) factors that determine the type of filler rod to use in oxy-acetylene fusion welding.

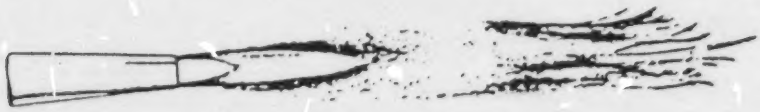
   a.

   b.

8. Describe the purpose of the filler rod.

Unit II Test (continued)

9. Identify the types of oxy-acetylene fusion welding flames.



a._____

b._____

c._____

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Answer Key - Teacher Evaluation

Unit II Test: OPERATING GAS WELDING EQUIPMENT

I. 1. a. Flux-A chemical used to clean metals and to promote fusion during the welding process.

b. Ductile-A term describing metal which is capable of being drawn or stretched out.

c. Malleability-A property of metals which allows them to be bent or permanently distorted without rupture; opposite of brittleness.

d. Braze welding-Heating the base metal to a dull red color and depositing a bead over the seam (joint) with a bronze filler rod; the base metal is not melted.

e. Tinning operation-Melting a small amount of bronze rod onto the surface and allowing it to spread along the entire seam (joint).

2. a. Brazing-A group of welding processes wherein coalescence (the forming together in one mass) is brought about by

1. Having a joint which requires only a thin film of filler metal

2. The distribution of filler metal between the closely fitted surfaces of the joint by capillary attraction

b. Braze welding-Performed in the same manner as fusion welding except that the base metal is not melted

1. The joint design is the same as used in fusion welding

2. The welding technique used for braze welding is the same as in fusion welding except that the base metal is raised only to the "tinning" temperature

3. a. Less need for extensive preheating

b. The low degree of heat minimizes expansion and contraction forces

c. Less possibility of destroying the main characteristics of the base metal

Unit II Answer Key (continued)

4. Any three (3) of the following:

   a. Not recommended for parts which are to be raised to temperatures higher than the melting point of bronze, either in service or during heat treatment

   b. It cannot be used on metal where stress is a factor

   c. Bronze may have corrosion-resistant properties which differ from those of the base metal being used

   d. Bronze will lose its strength at temperatures above 500° F.

5. Any four (4) of the following:

   a. Deoxidize the weld metal

   b. Decrease the tendency to fume

   c. Increase the free-flowing action of the molten metal

   d. Increase the hardness of the deposited metal for greater wear resistance

   e. Produce a high tensile strength

   f. Increase ductility

6. a. To guarantee the molten bronze will stick to the base metal

   b. To have a stronger bond on base metal

7. a. Mechanical-Wire brush or grinder

   b. Chemical-Flux

8. Any five (5) of the following:

   a. Chemically cleans the base metal

   b. Prevents oxidation of the filler metal

   c. Floats and removes the oxides already present

   d. Increases the flow of the filler metal

   e. Increases the ability of the filler metal to adhere to the base metal

Unit II Answer Key (continued)

8. f. Brings the filler metal into immediate contact with the metals being joined

g. Permits the filler metal to penetrate the pores of the base metal

9. Dull red

10. a. The molten bronze will spread out evenly and flow over a considerable area

b. The molten bronze will tend to boil and to form little balls

c. The molten bronze will not flow over the surface but will form into drops

II. 1. a. Flashback-Fire inside torch

b. Backfire-Momentary burning back of the flame into the tip

c. Flame cutting-A process by which iron or steel is heated to a temperature where it can be rapidly oxidized by high purity oxygen flowing under pressure through a cutting torch

d. Slag box-Metal container with a layer of water or sand to catch hot slag

e. Drag line-Refers to the situation in which the most distant portion of the cutting stream lags behind the stream nearest the cutting tip

f. Kerf-Area where the metal was removed in the form of an oxide during the cutting process

g. Oxide-Term usually applied to rust, corrosion, coating, film, or scale

h. Oxidizing-Combining oxygen with another substance

2. a. Oxygen fitting

b. Acetylene fitting

c. Oxygen torch valve

d. Acetylene torch valve

e. Torch body

Unit II Answer Key (continued)

2. f. Oxygen cutting lever

   g. Oxygen preheat valve

   h. Tip nut

   i. Slip-in tip

   j. Preheat orifice

   k. Cutting orifice

3. a. To catch hot slag

   b. To prevent fire

   c. To protect clothing

   d. To protect welding hoses

4. Any five (5) of the following:

   a. Preheat flames too small causing cutting speed to be too slow

   b. Preheat flames too long

   c. Oxygen pressure too low

   d. Oxygen pressure too high and nozzle size too small

   e. Cutting speed too slow

   f. Cutting speed too high

   g. Blowpipe travel unsteady

   h. Cut lost and not carefully restarted

5. Any four (4) of the following:

   a. Insufficient acetylene or oxygen pressure

   b. Loose cutting tip

   c. Dirty tip

   d. Overheating of cutting tip

   e. Bad O-ring in torch body

Unit II Answer Key (continued)

6. Description should include:

   a. Flame burns momentarily back into tip

   b. A loud snap or pop results

      1. Flame may go out

      2. Flame may continue to burn in normal manner

7. Description should include:

   a. Fire inside torch

   b. Disappearance of flame followed by

      1) Squealing or hissing noise inside torch

      2) Sparks coming from torch

      3) Smoke coming from torch

8. a. Close oxygen preheat valve

   b. Close oxygen torch valve

   c. Close acetylene torch valve

   d. Release oxygen regulator screw

   e. Release acetylene regulator screw

   f. Examine acetylene unit

   g. Reset regulator pressures

   h. Light torch

III. 1. a. A short weld used for temproarily holding material in place

   b. Joining of pieces of metal by heating the adjoining edges to the fusion or melting point and allowing them to flow or run together and then cool

   c. Metal being welded

   d. Distance from the original surface of the base metal to that point at which fusion ceases

Unit II Answer Key (continued)

1. e. A mixture with metallic properties composed of two (2) or more elements of which one is a metal

   f. The inner white part of the neutral flame

2. Any ten (10) of the following:

   a. Support oxygen and acetylene cylinders in an upright position so they cannot be tipped over.

   b. Blow out cylinder valves (crock cylinder valve for a second before attaching regulators) in order to remove dust and dirt that may damage regulator.

   c. Release pressure adjusting screw on regulator before opening cylinder valve in order to prevent damage to regulators and possible injury to operator.

   d. Stand to the side of regulators keeping the cylinder valve between operator and regulator when opening cylinder valves.

   e. Open cylinder valves slowly.

   f. Do not use acetylene (in free state) at pressures higher than 15 psi.

   g. Purge oxygen and acetylene passages (individually) before lighting torch.

   h. Light acetylene before opening oxygen torch valve.

   i. Never use oil or grease on regulators, torches, or fittings.

   j. Do not use oxygen as a substitute for compressed air.

   k. Use safety goggles, gloves, and protective clothing.

   l. Have CO_2 or dry powder type fire extinguisher available.

   m. Test connections for leaks with Ivory soap suds, paint brush, and water.

   n. Avoid lighting torch or cutting near combustible materials.

   o. Never open the acetylene cylinder valve more than 1/2-3/4 turns.

Unit II Answer Key (continued)

2. p. Always operate torch in a well-ventilated area.

   q. Never cut on containers that have been used for combustible materials.

   r. Avoid breathing toxic fumes when cutting.

   s. Place steel caps on all gas cylinders when they are being removed or stored to protect the valves.

   t. Shut off cylinder valves when not in use for any length of time to reduce the possibility of leakage and strain on the equipment.

   u. Turn acetylene torch valve off first in order that the flame will go out immediately.

   v. Keep hands, gloves, and clothing free from oil and grease.

   w. Never cut or weld too close to concrete.

   x. Always weld or cut at least five feet from cylinder.

   y. Always protect hoses from hot metal, rupture, or mechanical damages.

   z. Always light torch with a friction lighter.

   aa. Never leave a burning torch unattended.

3. a. Oxygen regulator

   b. Oxygen cylinder valve

   c. Acetylene regulator

   d. Acetylene cylinder valve

   e. Safety chain

   f. Cylinder truck

   g. Acetylene cylinder

   h. Oxygen cylinder

   i. Acetylene fitting

   j. Acetylene torch valve

Unit II Answer Key (continued)

3. k. Oxygen fitting
   l. Oxygen torch valve
   m. Welding torch body
   n. Welding tip
   o. Welding goggles
   p. Flint lighter
   q. Welding gloves
4. a. Proper flame adjustment
   b. Angle of tip
   c. Distance from work
   d. Speed of travel
   e. Movement of tip
5. a. Consistent width
   b. Straightness
   c. Slightly crowned
   d. Fused into base metal
   e. Clean appearance
6. a. Metal thickness
   b. Size of welding rod
7. a. Rod with similar properties as base metal
   b. Thickness of metal
8. To add strength to weld or joint
9. a. Carburizing
   b. Neutral
   c. Oxidizing

Teacher Evaluation

MODULE TEST

Unit III: OPERATING METALLIC AND TUNGSTEN INERT GAS WELDING EQUIPMENT (TIG), (MIG)
Module B: Welding with MIG Equipment

I. Match the following terms with the correct definition.

(1) Slope
(2) Arc voltage
(3) Slope control
(4) Ferrous
(5) Inductance
(6) Open circuit voltage
(7) Non-ferrous
(8) Stick out
(9) Short circuiting transfer (Short arc)
(10) FCAW
(11) Welding voltage
(12) Whiskers
(13) Welding current
(14) Gas metal arc welding (GMAW)
(15) Spray transfer (Spray arc)
(16) Shielding gases

_____ a. The heat generated by the flow of current through the gap between the end of the wire and the work piece; voltage appears across this gap and varies in the same direction as the length of the arc.

_____ b. A welding process performed in GMAW usually done on thicker metal using larger diameter wires and a shielding gas mixture of argon with 1-5% oxygen done in the flat and horizontal positions only.

_____ c. Will usually be DCRP with the welding wire positive (+) and the work negative (-).

_____ d. An arc welding process in which a consumable bare electrode is fed into a weld joint at a controlled rate while a continuous blanket of gas, inert or otherwise, shields the weld zone from contamination by the atmosphere.

_____ e. Abbreviation for flux cored arc welding; a form of GMAW performed with a cored consumable electrode (flux inside the wire).

Unit III-B MODULE TEST (continued)

_____ f. A welding application of the GMAW process where low currents, low voltages, and small diameter wires are used to weld on thin to heavy metals in all positions.

_____ g. Voltage indicated by a volt meter on GMAW power supply when machine is welding.

_____ h. Any metal containing iron such as mild steel or stainless steel.

_____ i. Any metal that contains no iron such as aluminum or magnesium.

_____ j. The slant of the volts versus amps curve, generally referred to as volts change per 100 amps.

_____ k. A control on the power supply that regulates the amount of pinch force available on the welding wire thereby controlling spatter or the pinch effect.

_____ l. Controls the rate of rise of current without controlling the final amount of current available.

_____ m. The distance from the contact tip of the gun to the end of the electrode.

_____ n. Short lengths of welding wire that feed through the root gap of a grooved joint and extend out from the root of the weld in all directions.

_____ o. Voltage indicated by volt meter on GMAW power supply when machine is running but not welding.

_____ p. Gases, inert or otherwise, used to displace the air around the arc to prevent contamination by oxygen, nitrogen, or hydrogen in the atmosphere.

Unit III-B MODULE TEST (continued)

2. Identify the major parts of the GMAW equipment.

a. h.

b. i.

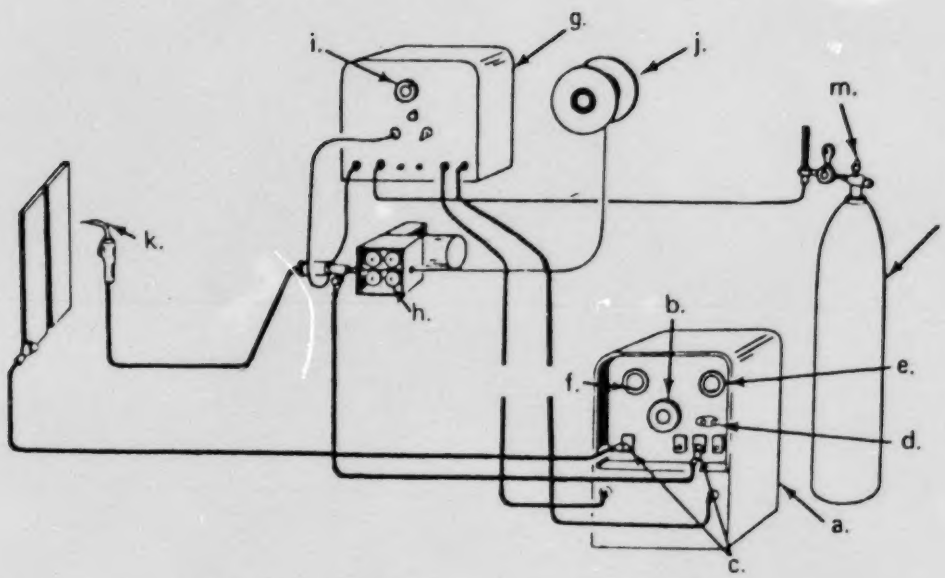
c. j.

d. k.

e. l.

f. m.

g.



3. Name the two (2) types of mild steel welding wires used in GMAW welding.

a.

b.

Unit III-B MODULE TEST (continued)

4. Identify the causes of poor welds by matching the cause to the illustration.

_____ a. Cold lapping

_____ b. Excessive penetration

_____ c. Insufficient penetration

_____ d. Burn-through

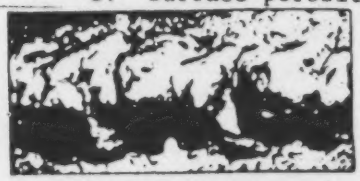
_____ e. Surface porosity

_____ f. Poor appearance

_____ g. Whiskers

_____ h. Bad tie-in

_____ i. Suck-back



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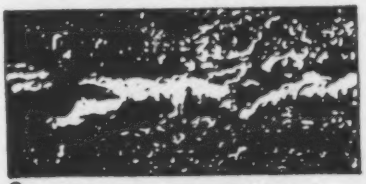

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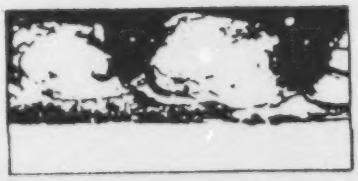

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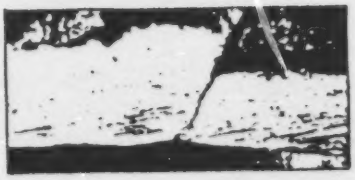

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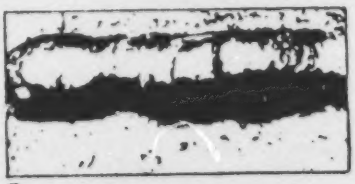

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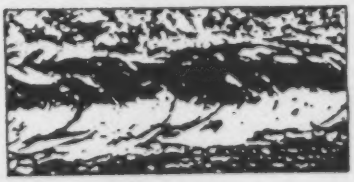

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Unit III-B MODULE TEST (continued)

5. List the characteristics of a good weld.

   a.

   b.

   c.

6. Describe the effects of electrode wire stick out on volts and amps.

   a. Increased stick out (long arc)

   b. Short stick out (short arc)

7. Demonstrate the ability to:

   a. Set up and shut down the GMAW equipment for short arc, spray arc, and flux cored arc welding applications.

   b. Construct a multiple pass T-joint fillet weld on 3/16" mild steel in the horizontal position with short arc.

   c. Construct a lap joint fillet weld on 3/16" mild steel in the vertical down position with short arc.

   d. Construct a square groove butt joint on 3/16" mild steel in the flat position with short arc.

   e. Construct a square groove butt joint on 3/16" mild steel in the horizontal position with short arc.

   f. Construct a multiple pass T-joint fillet weld on 1/4"-3/8" mild steel in the vertical up position with short arc.

   g. Construct a corner joint fillet weld on 1/4" mild steel in the vertical up position with short arc for break test.

   h. Construct a square groove butt weld on 3/16" mild steel in the vertical up position with a short arc.

   i. Construct a T-joint fillet weld on 1/4" mild steel in the overhead position with short arc for break test.

   j. Construct a square groove butt weld on 3/16" mild steel in the overhead position with short arc.

   k. Construct a T-joint fillet weld on 16 ga. mild steel in the horizontal position with short arc.

   l. Construct a single V-groove butt joint on 3/8" mild steel in the horizontal position with short arc for test.

Unit III-B MODULE TEST (continued)

m. Construct a single V-groove butt joint on 3/8" mild steel in the vertical down position with short arc for test.

n. Construct a single V-groove butt joint on 3/8" mild steel in the vertical up position with short arc for test.

o. Construct a single V-groove butt joint on 3/8" mild steel in overhead position with short arc for test.

p. Construct a multiple pass lap joint fillet weld on 1" mild steel in the horizontal position with spray arc.

q. Construct a multiple pass V-joint fillet weld on 1" mild steel in the flat position with flux cored wire.

r. Construct a T-joint fillet weld on 1/4" aluminum plate in the horizontal position with short arc.

s. Construct a multiple pass T-joint fillet weld on 1/4" aluminum plate in the vertical up position with short arc.

t. Construct a T-joint fillet weld on 1/8" stainless steel in the horizontal position with short arc.

u. Construct a square groove butt weld on 1/8" stainless steel in the flat position with short arc.

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

Answer Key - Teacher Evaluation

MODULE TEST

Unit III: OPERATING METALLIC AND TUNGSTEN INERT GAS WELDING EQUIPMENT (TIG), (MIG)
Module B: Welding with MIG Equipment

1.

a.	11	e.	10	i.	7	m.	8
b.	15	f.	9	j.	1	n.	12
c.	13	g.	2	k.	3	o.	6
d.	14	h.	4	l.	5	p.	16

2.
a. Power supply
b. Voltage control
c. Welding terminals
d. Power on-off switch
e. Volt meter
f. Amp meter
g. Wire feed control system
h. Feed rolls
i. Wire feed control (amperage)
j. Wire reel or coil
k. Gun
l. Shielding gas
m. Flowmeter

3.
a. Solid
b. Flux cored

4.

a.	4	d.	3	g.	9
b.	5	e.	8	h.	2
c.	6	f.	1	i.	7

5.
a. Even ripple on bead
b. Slight crown (convex) at root
c. Well fused throughout joint

6.
a. Increases arc volts and decreases amps
b. Increases amps and decreases arc volts

7. Performance skills will be evaluated to the satisfaction of the instructor.

Teacher Evaluation

MODULE TEST

Unit III: OPERATING METALLIC AND TUNGSTEN INERT GAS WELDING EQUIPMENT (TIG), (MIG)

Module C: Welding with TIG Equipment

1. Match the following terms with the correct definition.

(1)	Gas tungsten arc welding	(8)	Flowmeter
(2)	Inert shielding gas	(9)	Foot control
(3)	Tungsten electrode	(10)	Collet
(4)	High frequency current	(11)	Thermal conductivity
(5)	Aluminum oxide	(12)	Metallurgy
(6)	Gas cup	(13)	Porosity
(7)	Collet body (chuck)		

_____ a. A device used by the welder to control welding current during the welding process.

_____ b. A thin film that forms on the surface of aluminum due to a reaction between the metal and oxygen in the air.

_____ c. A chucking device used to hold the tungsten in the torch.

_____ d. The science and technology of metals.

_____ e. An arc welding process wherein coalescence (fusion) is produced by heating with an arc between a non-consumable tungsten electrode and the base metal utilizing an inert gas, argon, or helium that shields the weld zone from contamination by oxygen and nitrogen in the air.

_____ f. A calibrated metering device used to regulate the flow of gases to the torch and measured in cubic feet per hour (c. f. h.).

_____ g. A holding device for the collet.

_____ h. An attachment that fits on the end of the GTAW torch to direct the flow of shielding gas to the tungsten and weld zone.

Unit III-C MODULE TEST (continued)

_____ i. A gas which will not combine with other gases used to surround the weld zone and prevent contamination of the weld by oxygen and mitrogen in the air.

_____ j. The characteristic of a metal to conduct heat throughout its thickness, width, and length.

_____ k. Gas pockets or voids in metal.

_____ l. A high voltage low power source introduced into the A. C. weld current to start the arc and aid in oxide removal when welding aluminum.

_____ m. A practically non-consumable welding electrode used to create an intense arc between the tip of the electrode and the work.

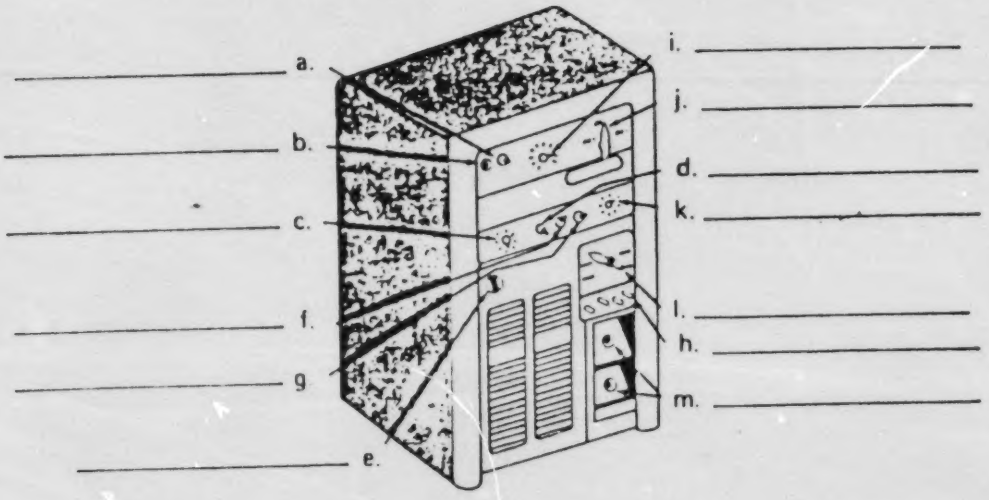
2. Name three (3) applications of the GTAW process.

   a.

   b.

   c.

3. Identify the major controls of the GTAW power supply from the drawing below.



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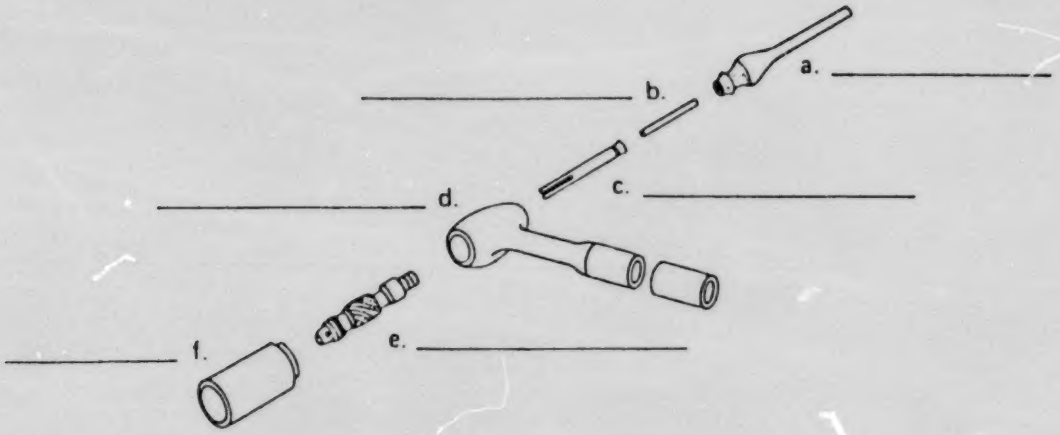
Unit III-C MODULE TEST (continued)

4. Identify the six (6) major parts of a GTAW torch from the drawing below.



5. Match the following filler metals to the correct base metals.

Aluminum

_____ 1.	Base metal 3003	a. 1100
_____ 2.	Base metal 5052	b. 5356
_____ 3.	Base metal 6061	c. 5652
_____ 4.	Base metal 5005	d. 4043

Stainless

_____ 1.	Base metal 347	a. 308
_____ 2.	Base metal 308	b. 316L
_____ 3.	Base metal 304 clad	c. 310
_____ 4.	Base metal 316L	d. 347

Unit III-C MODULE TEST (continued)

6. Name five (5) characteristics of a good weld.

a.

b.

c.

d.

e.

Answer Key - Teacher Evaluation

MODULE TEST

Unit III: OPERATING METALLIC AND TUNGSTEN INERT GAS WELDING EQUIPMENT (TIG), (MIG)
Module C: Welding with TIG Equipment

1. a. 9 e. 1 h. 6 k. 13
   b. 5 f. 8 i. 2 l. 4
   c. 10 g. 7 j. 11 m. 3
   d. 12

2. a. Makes top quality welds possible on most all metals and alloys used in industry.
   b. Welds possible in all positions through a wide range of metal thickness.
   c. Used particularly for aluminum and its alloys (even on very thin sections).

3. a. Remote control switch (foot control)
   b. Remote control receptacle (foot control)
   c. Gas afterflow timer (post purge 0-60 seconds)
   d. Soft start
   e. Power switch--On-off
   f. Weld control switch--SMAW or GTAW welding
   g. High frequency spark switch
      (1) On-off (2) Start only (3) Continuous
   h. Gas and water connections
   i. Fine adjustment current control
   j. Polarity switch, DCRP, AC, DCSP
   k. High frequency spark intensity rheostat
   l. Current range selector
   m. Ground and electrode terminals

4. a. Cap
   b. Electrode
   c. Collet
   d. Torch body
   e. Collet holder (body)
   f. Gas nozzle (cup)

5. Aluminum 1. a
   2. c
   3. b
   4. d

   Stainless 1. d
   2. a
   3. c
   4. b

6. a. Smooth edge
   b. Correct bead size
   c. Even penetration
   d. Even ripple
   e. Clean bright weld

Teacher Evaluation

Unit III: OPERATING METALLIC AND TUNGSTEN INERT GAS WELDING EQUIPMENT (TIG), (MIG)

1. Select five (5) advantages of the GTAW process from the following examples. (Place an "X" by the correct example.)

   _____ a. Slag and spatter easily removed

   _____ b. Welder has very close control of welding current

   _____ c. Arc and weld puddle clearly visible to welder

   _____ d. Welding speeds are much faster than the GMAW process

   _____ e. Minimum of distortion and stress with heat concentrated in a small area

   _____ f. No flux used and no post cleaning required

   _____ g. Makes excellent root pass on carbon and stainless steel pipe

   _____ h. Used exclusively on heavy plates where rapid production is necessary

   _____ i. Lends itself to assembly line use in the auto industry

2. List six (6) advantages of the GMAW process.

   a.

   b.

   c.

   d.

   e.

   f.

3. Name the two (2) types of welding current used most in GTAW welding.

   a.

   b.

Unit III Test (continued)

4. Select from the following list three (3) applications of the GMAW process. (Place an "X" in front of the application.)

_____ a. Short circuiting (short arc)

_____ b. Stick electrode

_____ c. Spray arc

_____ d. Gas welding

_____ e. Flux cored wire

5. Name four (4) factors to be considered when selecting a filler wire for the GMAW process.

a.

b.

c.

d.

6. Name the three (3) most commonly used gas cups for GTAW welding.

a.

b.

c.

7. Match the shielding gases to their use(s).

_____ a. Used to weld aluminum and magnesium

_____ b. Used to weld heavy sections of aluminum

_____ c. Used to weld mild and stainless steel

_____ d. Used for mild steel with short arc and flux cored application

_____ e. Used on mild, stainless, and alloy steels and copper alloys

1. Argon-CO_2
2. Argon
3. Argon-Helium
4. Helium; Argon; CO_2
5. CO_2
6. Argon-Oxygen

Unit III Test (continued)

8. Name the two (2) types of power sources for GMAW.

   a.

   b.

9. Name the color, finish, type, and application when given the type of tungsten electrode.

Type of Electrode	Color	Finish	Sizes	Applications
a. Pure				
b. 1% Thoriated				
c. 2% Thoriated				
d. Zirconiated				

10. List the major metallurgical factors to be considered when welding the following.

    Aluminum

    a.

    b.

    c.

    Stainless

    a.

    b.

11. List the characteristics of argon and helium shielding gases.

a. Argon	b. Helium
(1)	(1)
(2)	(2)
(3)	(3)
(4)	(4)

Answer Key - Teacher Evaluation

MODULE TEST

Unit III: OPERATING METALLIC AND TUNGSTEN INERT GAS WELDING EQUIPMENT (TIG), (MIG)

1. b
   c
   e
   f
   g

2. Any six (6) of the following:
   a. Arc always visible to the welder
   b. No slag and a minimum amount of spatter
   c. High disposition rates with 95% of the welding wire deposited in the joint
   d. Weld metal deposit of low hydrogen quality
   e. Wide range of metal thicknesses can be welded without changing wires
   f. Excellent for bridging gaps or misaligned joints without burn-through
   g. Greatly reduced distortion in gage metal
   h. Adaptable to weld most any metal by the selection of the correct filler wire and shielding gases
   i. Adaptable to either automatic or semi-automatic

3. a. Alternating current (AC) with high frequency for aluminum and magnesium
   b. Direct current straight polarity (DCSP) for mild and stainless steel

4. a
   c
   e

5. a. Metals to be welded
   b. Metal thickness and joint design
   c. Metal surface condition
   d. Specifications of the job

6. a. Ceramic b. Pyrex glass c. Metal

7. a. 2 c. 1 and 4 e. 6
   b. 3 d. 5

8. a. Transformer-rectifier
   b. Engine or motor generator

Unit III Answer Key (continued)

9. Color	Finish	Size	Application
a. Green	Ground or chemically etched	1/16, 3/32, 1/8, 5/32, 3/16, 1/4	Aluminum or magnesium
b. Yellow	Ground or chemically etched	1/16, 3/32, 1/8, 5/32, 3/16, 1/4	Mild or stainless steel
c. Red	Ground or chemically etched	1/16, 3/32, 1/8, 5/32, 3/16, 1/4	Mild or stainless steel
d. Brown	Ground or chemically etched	1/16, 3/32, 1/8, 5/32, 3/16, 1/4	Aluminum or magnesium

10. Aluminum
    a. Melting point--Aluminum melts at 1220°F but requires higher welding currents than other metals due to its high thermal conductivity.
    b. Aluminum oxide--Forms on the surface of aluminum when exposed to oxygen in the air; this oxide requires a temperature of 3700°F to melt or break down.
    c. Heat colors--Aluminum shows no heat colors as it approaches the melting point.
    d. Proper mechanical support--Since some aluminum alloys melt at 900°F care must be taken to support all areas subjected to the extreme heat of welding to prevent collapse, warping, and distortion.

    Stainless
    a. Thermal conductivity--Stainless steel dissipates heat from the weld zone 40% to 50% slower than mild steel.
    b. Distortion--Heat expansion in the weld zone is so slow, weld metal warpage is a problem.

11. a. Argon--Most popular gas for GTAW
        (1) Easily obtainable at low cost
        (2) Better shielding at lower flow rates (c.f.h.) than helium
        (3) Easier arc starting than helium
        (4) Better cleaning action when welding aluminum with AC current

    b. Helium--Used when welding thicker plates
        (1) Yields higher heat for comparable current than argon
        (2) Arc length is more critical than argon
        (3) Has higher welding speeds than argon
        (4) Produces poor arc stability and cleaning action

Teacher Evaluation

Unit IV: SET UP, TACK, AND WELD METAL PROCESSING PROJECTS

I. 1. Name the common equipment needed in shielded metal arc welding:

a.

b.

c.

d.

e.

f.

g.

h.

i.

j.

k.

2. Place a checkmark before the statement that signifies reverse polarity:

_____ a. Current flows from electrode to base metal

_____ b. Current flows from base metal to electrode

3. Place a checkmark before the statement that determines polarity:

_____ a. Type of flux on electrode

_____ b. Electrode

_____ c. Current

_____ d. Brand of welding machine

4. Name the two (2) types of operating adjustments found on arc welding equipment:

a.

b.

Unit IV Test (continued)

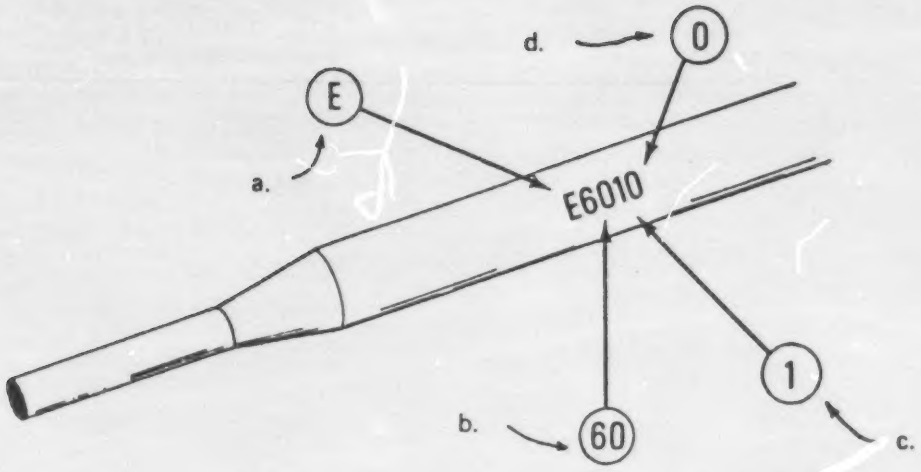
5. Identify the parts of the drawing below.

   a.

   b.

   c.

   d.



6. Name four (4) types of welds.

   a.

   b.

   c.

   d.

Unit IV Test (continued)

7. Identify the types of welding joints.

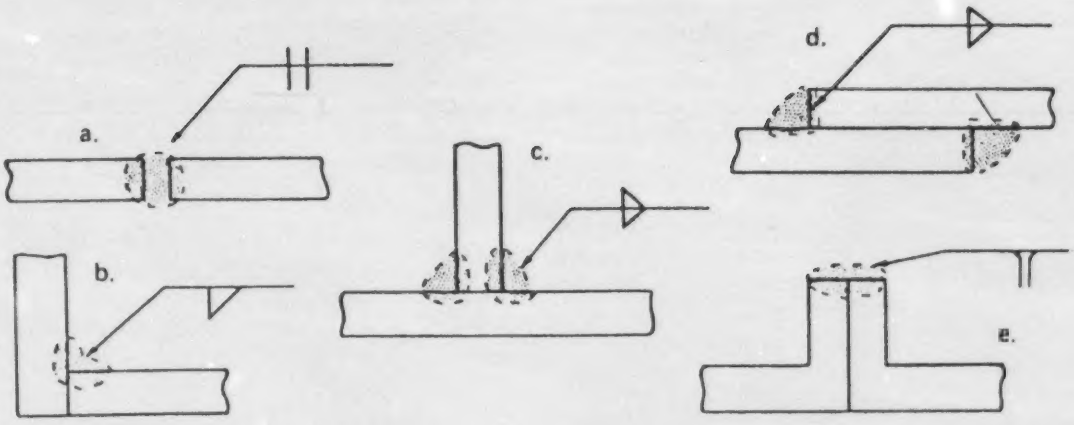
a.

b.

c.

d.

e.



8. Identify the parts of the welding process illustrated below.

a.

b.

c.

d.

e.

f.

g.

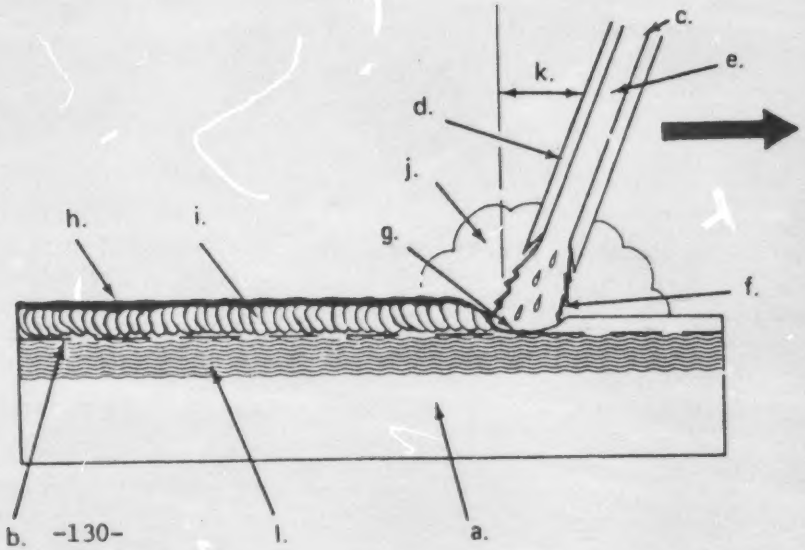
h.

i.

j.

k.

l.



Unit IV Test (continued)

9. Which of the following statements contribute to reasons for poor welds? Place a checkmark by your response.

_____ a. Improper angle of electrode

_____ b. Improper electrode and size

_____ c. Improper machine adjustment

_____ d. Improper clamping of electrode in holder

_____ e. Welding from left to right with the forehand technique

_____ f. Improper base metal preparation

_____ g. Running a E-6010 electrode on DCRP

_____ h. Improper arc length

10. Name the two (2) methods of striking an arc:

a.

b.

11. Name five (5) safety precautions to follow in shielded metal arc welding.

a.

b.

c.

d.

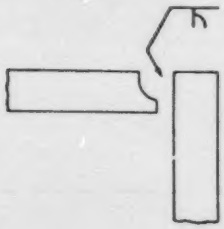
e.

140

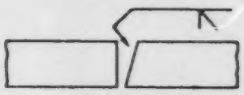
Unit IV Test (continued)

12. Identify the different types of groove joints.

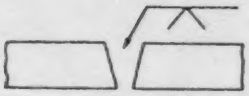
a. _____



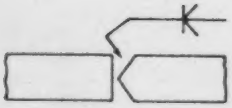
b. _____



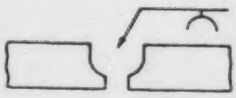
c. _____



d. _____



e. _____



f. _____

II. Performance

Perform the following operations:

1. Build a pad in the horizontal position.
2. Construct a multiple pass T-joint in the horizontal position.
3. Weld a square groove butt weld in the horizontal position.
4. Build a pad in the vertical up position.
5. Make a T-joint in the vertical up position.
6. Make a square groove butt joint in the vertical down position.

Unit IV Test (continued)

7. Build a pad in the overhead position.

8. Make a lap joint in the overhead position.

9. Lay out, cut, and prepare weld coupons for testing.

10. Test weld coupons.

11. Make a single V-groove joint in the flat position and test.

12. Make a single V-groove joint in the horizontal position and test.

13. Make a single V-groove joint in the vertical up position and test.

14. Make a single V-groove joint in the overhead position and test.

(NOTE: These are not test questions. Check with instructor if you have not completed these welding jobs.)

Answer Key - Teacher Evaluation

Unit IV: SET UP, TACK, AND WELD METAL PROCESSING PROJECTS

I. 1. a. Welding machine
b. Electrode holder with lead
c. Ground clamp with lead
d. Shield or helmet
e. Gloves
f. Chipping hammer
g. Safety goggles
h. Wire brush
i. Electrodes
j. Pliers
k. Protective clothing

2. b

3. a and b

4. a. Current
b. Polarity

5. a. Electrode
b. Tensile strength deposited in thousand pounds per square inch
c. Welding position--All positions
(1) All positions
(2) Flat and horizontal
d. Special characteristics
(1) Current
(2) Penetration
(3) Flux coating

6. a. Bead
b. Fillet
c. Groove
d. Plug

7. a. Butt
b. Corner
c. Tee
d. Lap
e. Edge

8. a. Base metal
b. Penetration
c. Electrode
d. Coating
e. Wire core
f. Arc
g. Crater
h. Slag
i. Weld
j. Gaseous shield
k. Ten degrees--fifteen degrees
l. Heat lines

9. a, b, c, f, and h

10. a. Tapping
b. Scratching

11. Any five (5) of the following:
a. Keep equipment in good, clean, dry condition.
b. Make sure all electrical connections are tight, clean, and dry.
c. Use correct size welding cable. Do not overload.
d. Be sure cables, holder, and connections are properly insulated.
e. Cut off power to welder before cleaning machine or making internal adjustments.

Unit IV Answer Key (continued)

f. Never change polarity or current settings while machine is under load.
g. Observe normal operating care for electrical hazards.
h. Keep work area neat, clean, and dry.
i. Remove flammable materials from welding area, or shield them.
j. Do not weld near volatile, flammable liquids, or gases.
k. Do not weld or cut on containers such as drums, barrels, or tanks until you know there is no danger of fire or explosion.
l. Dispose of hot electrode stubs in a metal container.
m. Never strike an arc on a compressed gas cylinder.
n. Protect your eyes from rays of the arc. Wear a headshield with the proper filter plates when welding or cutting.
o. Wear protective chipping goggles when chipping off weld slag.
p. Wear leather gloves and protective clothing such as an apron, sleeves, etc., to shield against the arc rays and sparks; button up shirt collar.
q. Use a non-reflecting welding curtain to protect others in the area from the arc rays.
r. Be sure work area has adequate ventilation and plenty of fresh air; special precautions are necessary when welding lead, zinc, beryllium copper, or cadmium.
s. Do not pick up hot metal.
t. Always open main switch or disconnect plug when checking over a welder.
u. Do not leave electrode holder on welding table or in contact with grounded metal surface.
v. Keep tools and metal in their proper locations.

12. a. Square
b. J-groove
c. Single bevel
d. Single V
e. Double bevel
f. U-groove

II. Performance: Operations performed will be evaluated by the instructor.

Teacher Evaluation

Unit V: CLEAN, TEST, AND CLASSIFY METALS

1. Define six (6) terms associated with metals.

   a. Metal--

   b. Metallurgy--

   c. Ore--

   d. Ferrous--

   e. Ductile--

   f. Weldability--

2. List common metals that can be welded.

   a.

   b.

   c.

   d.

   e.

3. List the major shapes of metals:

   a.

   b.

   c.

   d.

   e.

   f.

   g.

Unit V Test (continued)

4. List four (4) methods used for metal identification.

   a.

   b.

   c.

   d.

5. Classify metal as to ferrous or non-ferrous metals by placing "F" in front of ferrous and "N" in front of non-ferrous.

   _____ a. Low carbon steels

   _____ b. Alloy cast

   _____ c. Malleable cast

   _____ d. Brass

   _____ e. Low alloy, high tensile steel

   _____ f. Bronze

   _____ g. Nickel wrought

   _____ h. Aluminum

   _____ i. Low alloy steel castings

   _____ j. Zinc

   _____ k. Nickel

   _____ l. Clad steels

6. List the four (4) basic types of carbon steels.

   a.

   b.

   c.

   d.

Unit V Test (continued)

7. Describe the difference between low alloy, high tensile steels, and low carbon steels.

8. Discuss the properties of metals.

9. Discuss the major conditions that cause aluminum to be considered difficult to weld.

Answer Key - Teacher Evaluation

Unit V: CLEAN, TEST, AND CLASSIFY METALS

1. a. Metal--An element that has all or most of the following characteristics: solid at room temperature; opaque; conductor of heat and electricity; reflective when polished; expands when heated and contracts when cooled.
   b. Metallurgy--The science and technology of extracting metals from ores, refining them, and preparing them for use.
   c. Ore--The rock or earth in which we find metals in their natural form.
   d. Ferrous--Dominated by iron (Fe) in its chemical composition.
   e. Ductile--Refers to the ability of a material to become permanently deformed without failure.
   f. Weldability--Refers to the capacity of a metal to be fabricated by welding under improved conditions into a structure adequate for the intended purpose.

2. Any five (5) of the following:
   a. Steel
   b. Iron
   c. Aluminum
   d. Copper
   e. Magnesium
   f. Alloys of the above

3. a. Structural and bar shapes
   b. Sheets and strips
   c. Plates
   d. Hot rolled bars
   e. Cold finished bars
   f. Tubings
   g. Pipes

4. Any four (4) of the following:
   a. Appearance
   b. Spark test
   c. Manufacturer's stamp
   d. Color code
   e. Magnet reaction
   f. Filing the surface

5. a. F d. N g. F j. N
   b. F e. F h. N k. N
   c. F f. N i. F l. F

6. a. Low carbon
   b. Medium carbon
   c. High carbon
   d. Very high carbon

7. Description should include:
   a. Low alloy, high tensile steels
      (1) High yield strength and ductile
      (2) Small content of alloying elements
      (3) Higher priced
      (4) Can use thinner sections
      (5) Resistant to corrosion
      (6) High impact and endurance
      (7) Ease of forming
      (8) Good weldability
      (9) Low carbon content

Unit V Answer Key (continued)

b. Low carbon
   (1) Tough
   (2) Ductile
   (3) Easily formed
   (4) Machineable
   (5) Excellent weldability
   (6) Wide variety of uses

8. Discussion should include:
   a. Mechanical properties
      (1) Compression strength
      (2) Tensile strength
      (3) Hardness
      (4) Ductility
      (5) Brittleness
   b. Physical
      (1) Density
      (2) Resistant to corrosion
      (3) Electrical and thermal conductivity
      (4) Thermal expansion

9. Discussion should include:
   a. Very active metal (chemically)
   b. Oxidizes easily at room temperature
   c. Does not change color when it approaches the melting point
   d. Dissipates heat five (5) times faster than steel
   e. Requires support (back-up bars) on thin sections to prevent sagging weld joint
   f. Requires thorough cleaning previous to welding

Teacher Evaluation

Unit VI: OPERATING AUXILIARY EQUIPMENT AND TOOLS

I. 1. Name three (3) main parts of the hand hacksaw:

a.

b.

c.

2. The blade of a hand hacksaw is installed with the teeth pointing _____.

3. How many strokes per minute should be used with hand hacksaws?

_____.

4. Why should a new blade never be used in a cut made by an old blade?

5. Name four (4) causes of blade breakage:

a.

b.

c.

d.

6. List four common hand hacksaw blades and their application:

a.

b.

c.

d.

7. What is meant by chipping?

Unit VI Test (continued)

8. Name five (5) types of files:

   a.

   b.

   c.

   d.

   e.

9. What is meant by a safe edge?

10. Name six (6) spacings between teeth on file:

    a.

    b.

    c.

    d.

    e.

    f.

11. What is accomplished by draw filing?

12. Why should a file be cleaned?

13. Name four (4) types of abrasive paper:

    a.

    b.

    c.

    d.

Unit VI Test (continued)

14. Abrasive papers are rated by _____.

15. List three (3) personal safety practices when operating power equipment:

    a.

    b.

    c.

II. Demonstrate proper use of the following, as directed by your instructor:

    a. Hand files

    b. Abrasive papers and materials

    c. Hand hacksaw

    d. Power hacksaws

    e. Power disc sanders

Answer Key - Teacher Evaluation

Unit VI: OPERATING AUXILIARY EQUIPMENT AND TOOLS

I. 1. a. Frame
b. Handle
c. Blade

2. Away from the handle

3. 40 cutting strokes per minute

4. Old blades cut a narrower kerf and the new blade will dull.

5. a. Loose blade
b. Loose work
c. Too much pressure
d. Blade sticking

6. a. 14 teeth - soft steel, aluminum, brass, copper, over 1" thick
b. 18 teeth - steel, angle iron, drill rod, aluminum, copper, 1/4 to 1" thick
c. 24 teeth - 1/16 to 1/4" thick
d. 32 teeth - material up to 1/16" thick

7. Removal of slag from welding.

8. Warding, mill, flat, hand, pillar, square, round, half-round, three square, knife

9. A file face that does not have teeth

10. Rough, coarse, bastard, second cut, smooth, and dead smooth

11. To obtain finely finished surface

12. To prevent the teeth from becoming clogged

13. Emery, silicon, carbide, metalite, crocus

14. Grit

15. a. Wear eye protection.
b. Do not wear loose clothing.
c. Do not wear rings or watches.

II. The instructor will evaluate the student's competence in using the equipment/tools/materials.

Teacher Evaluation

Unit VII: PERFORMING STRUCTURAL OR EQUIPMENT WELDING AND CUTTING OPERATIONS

The student should be given blueprints for metal projects, selected by the instructor. The student will:

1. Obtain the necessary material.

2. Select welding equipment.

3. Fabricate the metal project(s).

4. Evaluate the project.

5. Provide a written description which summarizes:

   a. Material choice
   b. Welding equipment choice
   c. Welding procedures used
   d. Evaluation of the project(s)

Answer Key: The instructor will evaluate (1) The finished project(s), and (2) The written description.

Teacher Evaluation

Unit VIII: WELDER CERTIFICATION TEST

The student will apply for and take the State Welding Certification Test.

Answer Key: The student will pass the State Welding Certification Test.

Unit VIII

INSTRUCTIONS FOR COMPLETING THE WELDING CERTIFICATION TEST REPORT

The Welding Certification Test Report should be completed by the welding instructor as per the following instructions. A copy of all test reports should be maintained by the welding instructor.

1. Proper name of school.
2. Complete address of school.
3. Welder's full name and address.
4. Actual test material thickness (Plate).
5. Nominal pipe diameter.
6. Actual test material thickness (Pipe).
7. Electrode identification number (E6010, HB18, oxyweld 7-these are examples).
8. Diameter of electrode or electrodes.
9. Proper name of welding process, Shielded Metal Arc, Gas Metal Arc (MIG or TIG), ocy-acetylene.
10. List the starting date and completion test date.
11. Show the number of coupons after the appropriate position and under face or root bends as the case may be.
12. List the weld defects as to their size in length. Aggregate defects should be listed as A-(Size).
13. Indicate the number of coupons under the respective face or root bend column followed by the letter to indicate the position being retested, such as H - horizontal, V - vertical, and O - overhead.
14. Indicate defects as per instructions of No. 12.
15. List any explanatory remarks regarding the test or form.
16. Signature of the instructor who supervised the test and completed the test report.
17. Date of signature.
18. Signature of the inspector who reviews coupons or initials of the inspector who reviews the report.
19. Date of signature or initials.

STATE OF WEST VIRGINIA
THE DEPARTMENT OF LABOR
Charleston 25305

WELDING CERTIFICATION TEST REPORT

Test Site 1

Address 2 Zip 2

WELDER'S NAME 3 ADDRESS 3

3 Zip 3

Material Thickness: Plate Thickness 4 Pipe Diam. 5 Thickness 6 Electrode Size 7 8

Welding Process 9 Test Date(s) 10

FACE BENDS		ROOT BENDS	
Position	Describe Defects	Position	Describe Defects
Horizontal	12	Horizontal	12
Vertical		Vertical	
Overhead		Overhead	
Retest 13	14	Retest 13	14

Remarks 15

The undersigned certifies that the information as stated in this report is correct and that the test welds were prepared, welded, and bent in accordance with the State of West Virginia Welding Certification Test Procedure.

Welding Instructor 16 Dept. of Labor Inspector 18

Date 17 Date 19

Mail this form immediately to the Department of Labor - Attention of Chief Boiler Inspector.

Teacher Evaluation

Unit IX: SUPERVISION, TRAINING, AND JOB ESTIMATING

I. The instructor will assign two (2) jobs to be performed in each of the following areas:

   1. Job estimating
   2. Training
   3. Supervising

II. For each assigned job, the student will:

   1. Plan and perform the job.
   2. Provide a written description of:
      a. Procedures
      b. Justification of procedures
      c. Evaluation of job and procedures used

Answer Key: The instructor will evaluate the student's performance on each of the jobs assigned.

The instructor will evaluate the student's written description of procedures, justification of procedures, and evaluation of job and procedures used.

REFERENCE MATERIALS

REFERENCE MATERIALS FOR WELDING CURRICULUM

Part I of this section lists reference materials specified in the learning activities of this curriculum. It is recognized that many of the recommended books or audio-visual materials may not be currently available in local school programs or libraries. Many may, however, be available on loan from:

Vocational Curriculum Laboratory
Cedar Lakes Conference Center
Ripley, West Virginia 25271
(304-372-8673)

Part II is a list of other resources that may be useful. These, too, may be available from the Cedar Lakes Vocational Curriculum Laboratory.

Part III of this section lists the texts, workbooks, and other materials that are currently used in welding programs in West Virginia, as reported by teachers of these programs.

Part I - References Cited in Learning Activities

A. Texts/Reference Books

1. Althouse, Andrew D., Carl H. Turnquist and William A. Bowditch. Modern Welding. South Holland, IL: The Goodheart-Willcox Co., Inc., 1970.

2. Archer, Fred C., Raymond F. Brecker, John C. Frakes, John C. Stewart, and Jeffrey Rig. General Office Practice, 3rd Ed. New York, NY: McGraw-Hill, 1968.

3. Austin, John B. Electric Arc Welding. Chicago, IL: American Technical Society, 1952.

4. Bennet, A. E. and Louis J. Siy. Blueprint Reading for Welders. Albany, NY: Delmar Publishing Co., 1973.

5. Bennet, A. E. and Louis J. Siy. Blueprint Reading for Welders, Instructor's Guide. Albany, NY: Delmar Publishing Co., n.d.

6. Bolles, Richard. What Color Is Your Parachute? Penn Speed Press.

7. Cowan, Earl, Clifton Baker, Wayman Penner, and Bob Patton. Vocational Trade and Industrial Education--Welding. Stillwater, OK: State Department of Vocational and Technical Education, 1974.

8. DeBrum, S. Joseph, Peter G. Haines, Dean R. Malsbary, and Anne Scott Daughtrey. General Business for Economic Understanding, 11th Ed. South-Western Publishing Company, 1976.

9. Giachino, Joseph. Gas Welding. Chicago, IL: American Technical Society, 1977.

10. Giachino, Joseph, William Weeks and Elmer Brune. Welding Skills and Practices, 5th Ed. Chicago, IL: American Technical Society, 1977.

11. How to Read Shop Drawings. Cleveland, OH: The Lincoln Electric Company.

12. Kennedy, Gower A. Welding Technology, 1st Ed. Indianapolis, IN: Howard W. Sams and Company, 1974.

13. Kimbrell, Grudy and Ben S. Vineyard. Succeeding in the World of Work. Bloomington, IL: McKnight Publishing Company, 1975.

14. Krar, Oswald, and St. Amand. Machine Shop Operations. New York, NY: McGraw-Hill Ryerson, 1975.

15. Masonry Simplified, Vol. I. Chicago, IL: American Technical Society, 1966.

16. Masonry Simplified, Vol. II. Chicago, IL: American Technical Society, 1966.

17. McCarthy, W. J., and R. E. Smith. Machine Tool Technology. Bloomington, IL: McKnight & McKnight Publishing Company, 1968.

18. Metals and How to Weld Them. Cleveland, OH: James F. Lincoln Arc Welding Foundation, n.d.

19. New Lessons in Arc Welding. Cleveland, OH: The Lincoln Electric Company, n.d.

20. Nicholson. Shop Theory. Dearborn, MI: McGraw-Hill, 1968.

21. Olivo, C. Thomas and Thomas P. Olivo. Basic Mathematics Simplified. Albany, NY: Delmar Publishers, 1977.

22. Pennsylvania Industrial Arts Safety Guide. Harrisburg, PA: Pennsylvania Department of Education, Industrial Arts Association of Pennsylvania, 1978.

23. The Procedure Handbook of Arc Welding, 12th Ed. Cleveland, OH: The Lincoln Electric Company, 1973.

24. Procedure Handbook of Arc Welding Design and Practice, 11th Ed. Cleveland, OH: The Lincoln Electric Company, 1957.

25. Sacks, Raymond. Welding Principles and Practices. Peoria, IL: Chas. A. Bennett Co., Inc., 1976.

26. Sacks, Raymond. Welding Principles and Practices - Student Guide. Peoria, IL: Chas. A. Bennett Co., Inc., 1977.

27. Schell, Frank R. Welding Procedures: Electric Arc. Albany, NY: Delmar Publishing Co., 1977.

28. Schell, Frank R. Welding Procedures: Oxyacetylene. Albany, NY: Delmar Publishing Co., 1977.

29. Schell, Frank R. and Bill Matlock. Welding Procedures: MIG and TIG. Albany, NY: Delmar Publishers, 1978.

30. U.S. Department of Labor, Employment and Training Administration. Dictionary of Occupational Titles, 4th Ed. Washington, DC: U.S. Department of Labor, 1977.

31. U.S. Department of Labor, Manpower Administration. Handbook for Analyzing Jobs. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, 1972.

32. U.S. Department of Labor, Manpower Administration. Occupational Outlook Handbook, 1978-79 Edition. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, 1978.

33. Wagener, Albert and H. R. Arthur. Machine Shop Theory and Practice, 2nd Ed. Van Nostrum, 1950.

34. Wakeman, Truman. Modern Agricultural Mechanics. Danville, IL: Interstate Printers and Publishers, 1977.

35. Walker, John R. Modern Metalworking. South Holland, IL: Goodheart Co., 1976.

36. Welding Alcoa Aluminum. Pittsburgh, PA: Aluminum Company of America, n.d.

37. Welding Skills and Technology, Shielded Metal Arc. Columbia, MO: University of Missouri, Department of Practical Arts and Vocational-Technical Education, Instructional Materials Laboratory, 1971.

B. Audio-Visual Materials

1. "Arc Welding." D.C.A. Educational Products No. W-51.

2. Singer Career Systems. Job Survival Skills Program. Rochester, NY: Singer Education Division, 1973.

Distributor: Associated Educational Consultants, Inc.
North Allegheny Office & Research Park
McKnight and Pine Creek Roads
Pittsburgh, PA 15237

Part II - Other Resources

1. Alabama Division of Vocational Education, Matthews, Howard A., Dir. "Welding Final," Time Free Modular Competency Based Curriculum. Montgomery, AL: Link Educational Laboratories, 1973.

2. Alabama Division of Vocational Education, Matthews, Howard A., Dir. "Welding Initial," Time Free Modular Competency Based Curriculum. Montgomery, AL: Link Educational Laboratories, 1973.

3. Alabama Division of Vocational Education, Matthews, Howard A., Dir. "Welding Instructional Resource," Time Free Modular Competency Based Curriculum. Montgomery, AL: Link Educational Laboratories, 1973.

4. Alabama Division of Vocational Education, Matthews, Howard A., Dir. "Welding Intermediate," Time Free Modular Competency Based Curriculum. Montgomery, AL: Link Educational Laboratories, 1973.

5. An Analysis of the Welding Occupation, Columbus, OH: The Ohio State University, Instructional Materials Laboratory, Trade and Industrial Education, n.d.

6. Anderson, James and Earl Tatro. Shop Theory, 5th Ed. Dearborn, MI: McGraw-Hill, 1968.

7. Cooper, Gloria S. and Joel H. Magisos, Eds. Metrics for Welding and Cutting. Columbus, OH: The Center for Vocational Education, Ohio State University, 1976.

8. Course Behavioral Objectives in Welding, Basic Arc for 1st, 2nd and 3rd Levels. Delaware County Area Vocational-Technical Schools, n.d.

9. Giachino, Joseph. Student Activity Manual for Welding Skills and Practices. Chicago, IL: American Technical Society, 1977.

10. Griffin, Ivan H. and Edward M. Roden. Basic TIG and MIG Welding. New York, NY: Delmar Publishing Company, n.d.

11. Kugler, Harold L. Arc Welding Lessons for School and Farm Shop. Cleveland, OH: The James F. Lincoln Arc Welding Foundation, 1975.

12. Lawrence, Layle D. and John William Cullens, Jr. Basic Skills in Oxyacetylene Welding, Casting, and Brazing. Morgantown, WV: West Virginia University, College of Agriculture and Forestry, Agricultural Education, Division of Reserve Management, July, 1977.

13. Metal Fabrication, Welding and Cutting. Lincoln, NB: Trade Preparatory Training Guide, Nebraska Department of Education, Division of Vocational Education, n.d.

14. Pucci, Alex L. and George F. Reichel. An Analysis of the Welding Occupation. Columbus, OH: The Ohio State University, The Instructional Materials Laboratory, Trade and Industrial Education, 1974.

15. The Oxyacetylene Handbook: A Manual on Oxyacetylene Welding and Cutting Procedures. New York, NY: Union Carbide Corporation, Linde Division, n.d.

16. Vocational Industrial Education Service. Welding. Charleston, WV: West Virginia Bureau of Vocational, Technical and Adult Education, n.d.

Part III - Reference Materials Currently Used in West Virginia

A. Texts/Reference Books

	Title	Author or Publisher	County Where Used
1.	Arc Welding Instructions for the Beginner	Lincoln	McDowell
2.	Arc Welding Lessons for School and Farm Shop	Lincoln	McDowell
3.	Basic Mig & Tig, Arc, Oxy.	Delmar	Cabell Upshur
4.	Blueprint Reading for Welders	Delmar	Brooke Upshur
5.	Lincoln Arc Welding	Lincoln Electric	Ohio
6.	Metalwork	Oswald A. Ludwig & Willard J. McCarthy	Wayne
7.	Modern Welding	Goodhart-Willcox Co., Inc.	Calhoun Greenbrier Kanawha Mason Monongalia
8.	Modern Arc Welding	Hobart	Cabell McDowell
9.	New Lessons in Arc Welding	Lincoln Electric	Brooke Lincoln Marion McDowell Mercer Pocahontas
10.	Oklahoma Vocational T.E.	--	Pleasants
11.	The Oxy-Acetylene Handbook	Linde Union Carbide	Cabell Lincoln
12.	Pipe Welding Procedures	Industrial Press, Inc.	Cabell
13.	Procedure Handbook of Arc Welding Design & Practice	Lincoln	Cabell
14.	Welding	McGraw Hill	Cabell

	Title	Author or Publisher	County Where Used
15.	Welding and Cutting Manual	Lincoln	McDowell
16.	Welding Principles & Practices	Chas. A. Bennett	Harrison Kanawha Marion McDowell Mercer Mineral Taylor Tucker
17.	Welding Skills and Practices	American Technical Society	Calhoun Hancock Monongalia Nicholas
18.	Welding Skills and Practices	Giachino-Weeks-Brune	Kanawha
19.	Welding Technology	American Technical Society	McDowell

B. Workbooks

1.	Basic Arc Welding	--	Lincoln
2.	Basic Blueprint Reading and Sketching	--	Mercer
3.	Basic Oxy-Acetylene Welding	--	Lincoln
4.	Basic TIG & MIG Welding	--	Lincoln
5.	Blueprint Reading for Welders	--	Harrison
6.	General Metalwork, Arc Welding Basic Fundamentals	--	McDowell
7.	New Lessons in Arc Welding	Lincoln	Ohio
8.	Pipe Welding Techniques	Delmar	Lincoln
9.	Programmed Audio-Visual Training Set	Hobart	Brooke Greenbrier

	Title	Author or Publisher	County Where Used
10.	Welding Principles and Practices	Chas. A. Bennett Co.	Harrison Marion McDowell Mineral Tucker
11.	Welding Principles and Practices	Delmar	Harrison
12.	Welding Skills and Practices	Student Guide	Nicholas
13.	Welding Skills and Practices	Giachino	Kanawha Webster
14.	Welding Technology	American Tech. Society	McDowell

C. Manufacturers' Manuals

1.	AIRCO - Oxy-Ace Welding and Cutting Instruction	AIRCO	Harrison
2.	Basic Blueprint Readings and Sketching	--	Lincoln
3.	Blueprint Reading for Welders	--	Brooke Lincoln
4.	Complete Metalworking Manual	--	McDowell
5.	Lincoln Electric	--	Tucker
6.	Miller Electric Company	--	Harrison
7.	New Lessons in Arc Welding	Lincoln	Brooke
8.	Welding Principles and Practices	--	Mercer
9.	Various Manuals from Hobart, Linde and Lincoln Companies		McDowell

D. Other Material

1.	AIRCO, Harris Victor, literature	--	McDowell

	Title	Author or Publisher	County Where Used
2.	Aluminum Trainers Manual	--	Harrison
3.	Blueprint Book: Welding Symbols	--	Mason
4.	Blueprint Reading for Welders	--	Kanawha Webster
5.	Blueprint Symbols, Drawing	--	Ohio
6.	Lincoln Filmstrips	--	Upshur
7.	Oregon Department of Education Ind. Mech. CBE	--	Calhoun
8.	Texas Trade and Industrial Welding Series	--	Tucker
9.	Welding, Suggested Basic Course Outline	Texas A & M University	Mason

APPENDIX A

RESPONSES TO VALIDATION SURVEY

APPENDIX A-1

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS
1978

Background Data	West Virginia (N=49) %	Pennsylvania (N=50) %
1. Sex		
Male	98	100
Female	2	0
2. Time Spend on Present Job		
1-5 years	32	30
6-10 years	34	32
11-20 years	20	18
21-39 years	10	16
3. Years Spent in Career Field		
10 years or less	16	10
11 to 15 years	14	10
16 to 20 years	26	18
21 to 25 years	12	16
26 to 30 years	6	12
31 to 35 years	8	10
36 to 41 years	4	22
4. Present Position by Job Title		
1. Welder	16	10
2. Pipefitter	2	(
3. Vocational Director	2	2
4. Supervisor	6	16
5. Foreman	16	10
6. Owner	4	0
7. Instructor/Teacher	43	42
8. Repairman	2	0
9. Mechanic	0	0
10. Shuttle Car Operator	2	0
11. Vice President	2	4
12. Inspector	2	0
13. Retired	0	2
14. Department Manager	2	2
15. Maintenance	0	2
16. Consultant	0	2
17. Technical Representative	0	6

APPENDIX A-2

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS
BY LOCATION - 1978

1 = Never
2 = Seldom
3 = Sometimes
4 = Often

Tasks	West Virginia N = 49				Pennsylvania N = 50			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
A. SUPERVISION, TRAINING AND JOB ESTIMATING								
1. Assign work to others	20	8	6	59	16	12	8	62
2. Plan and schedule work assignments	22	6	10	55	24	8	6	60
3. Instructor checklist	53	4	[illegible]	29	58	2	4	34
4. Prepare annual shop budgets	67	10	2	14	56	12	10	22
5. Write performance standards for jobs	61	12	8	14	50	20	14	16
6. Conduct oral safety briefings	35	4	16	39	36	10	8	44
7. Improve work methods	24	35	35	6	24	2	32	40
8. Estimate cost of repairs	57	8	12	16	42	12	20	26
9. Estimate labor and material costs of new fabrication	53	10	18	12	42	18	16	24
10. Prepare accident report	35	35	12	14	38	20	20	20
11. Plan and conduct on-the-job training for employees	51	18	8	18	40	6	26	28
12. Instructor checklist	73	2	18	6	66	4	4	26
13. Interview job applicants	69	10	8	6	62	16	8	14
14. Receive and record new shipment of supplies	37	10	20	24	40	12	14	30
15. Read and interpret detail sketch from blueprint	29	10	16	39	22	34	40	4
B. SET UP, TACK AND WELD METAL PROCESSING PROJECTS								
1. Select metals for fabrication from blueprint specifications	35	8	20	31	34	2	26	36
2. Draw sketches for shop or field projects	29	12	29	24	36	8	22	32
3. Research technical publications for welding standards	55	10	20	8	38	12	30	18
4. Set up and tack weld tee joints	14	2	16	63	10	6	10	70
5. Set up and tack weld upon butt joints	8	2	18	67	10	6	6	74
6. Set up and tack weld corner or edge joints	14	6	8	67	8	8	10	70
7. Set up and tack weld in the flat position	12	2	10	71	8	6	8	74

APPENDIX A-2

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS
BY LOCATION - 1978 (Continued)

Tasks	West Virginia N = 49				Pennsylvania N = 50			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
8. Set up and tack weld in the horizontal position	14	2	12	67	8	6	14	68
9. Set up and tack weld in the overhead position	16	18	6	65	12	22	12	50
10. Set up and tack weld in the vertical position	14	2	14	65	8	12	14	62
11. Set up and tack weld lap joints	16	6	15	57	10	8	20	58
12. Set up and make a plug or slot weld	20	8	35	33	22	14	22	36
13. Clamp metal work to prevent distortion and tack weld	16	2	18	59	14	8	22	52
C. CLEAN, TEST AND CLASSIFY METALS								
1. Examine and identify metals	22	6	31	37	20	8	32	36
2. Clean metals with solvent	43	20	20	12	34	22	26	16
3. Test metals using guided bend tester	49	10	6	33	40	10	18	28
4. Inspect welds using dye penetrant methods	63	18	12	2	40	18	28	12
D. OPERATING AUXILIARY EQUIPMENT AND TOOLS								
1. Chip slag using chipping hammer	12	2	8	73	8	6	8	76
2. Cut materials with hand hacksaws	14	20	39	22	22	22	30	24
3. Drill metal using power drilling equipment	10	6	39	41	22	8	28	40
4. Grind metal with power equipment	4	2	14	76	6	8	14	70
5. Cut metal with power hacksaw	31	8	24	33	32	8	16	42
6. Wire brush with power equipment	14	10	27	45	26	6	28	38
7. Finish metal surfaces with hand tools	29	10	24	33	26	18	28	26
8. Shear and punch metal shapes using iron working machine(s)	57	4	10	24	62	4	16	18
E. OPERATING GAS WELDING EQUIPMENT								
1. Set up portable or stationary oxy-fuel equipment	10	6	22	57	16	4	16	62
2. Braze ferrous and non ferrous metals with gas equipment	18	12	27	39	20	16	22	40

APPENDIX A-2

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS
BY LOCATION - 1978 (Continued)

Tasks	West Virginia N = 49				Pennsylvania N = 50			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
3. Change oxygen, acetylene or MAPP gas cylinders	8	6	14	67	12	6	16	64
4. Clean welding and cutting tips on oxy-fuel equipment	4	2	24	65	16	2	12	68
5. Cut carbon steels with oxy-acetylene equipment	10	8	8	69	14	2	16	66
6. Forge metals with gas equipment	37	20	24	16	52	16	18	12
7. Gas weld cast iron	27	20	33	16	30	30	18	20
8. Gas weld copper or copper alloys	49	20	22	4	46	30	14	10
9. Silver braze copper pipe joints	41	33	22	4	30	34	22	12
10. Gas weld carbon steels	22	18	33	22	36	10	12	40
11. Braze repair castings	20	31	31	14	26	16	36	20
12. Lead solder ferrous and non ferrous metals with gas equipment	55	29	10	2	44	28	20	6
13. Perform soap and water and/or submerged leak test and repair gas welding equipment	35	14	22	24	32	14	22	30
14. Shape metals using gas welding equipment	22	12	33	29	26	10	26	36
15. Silver braze ferrous metals with gas equipment	37	20	24	14	30	20	32	16
16. Silver braze non ferrous metals with gas equipment	45	24	22	4	34	26	28	10
17. Remove distortion using gas welding equipment	33	20	24	18	20	28	36	14
F. OPERATING METALLIC AND TUNGSTEN INERT GAS WELDING EQUIPMENT (TIG), (MIG)								
1. Weld aluminum or aluminum alloys with GMAW (MIG) equipment	33	20	20	22	30	20	14	34
2. Weld aluminum or aluminum alloys with GTAW (TIG) equipment	29	20	14	33	22	8	4	64
3. Weld stainless steel alloys with GMAW (MIG) equipment	37	31	16	12	42	18	16	24
4. Weld carbon steels with GMAW (MIG) equipment	14	20	18	43	16	4	8	70
5. Disassemble and clean a GMAW (MIG) torch assembly	16	16	37	27	14	6	24	54

APPENDIX A-2

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS
BY LOCATION - 1978 (Continued)

Tasks	West Virginia N = 49				Pennsylvania N = 50			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
6. Disassemble and clean a GTAW (TIG) torch assembly	33	20	16	27	22	10	26	40
7. Weld chrome-moly steel with GTAW (MIG) equipment	63	24	8	4	62	20	14	4
8. Weld copper or copper alloys with GTAW (TIG) equipment	57	16	20	2	54	24	16	4
9. Weld heat and corrosion resistant (stainless) steels with GTAW (TIG) equipment	45	18	22	8	38	12	16	32
10. Weld carbon steels with GTAW (TIG) equipment	35	27	14	18	28	6	16	48
11. Weld magnesium alloys with GTAW (TIG) equipment	51	27	10	8	54	20	22	4
G. OPERATING SHIELDED METALLIC ARC WELDING EQUIPMENT								
1. Shielded metallic arc-weld cast iron	29	27	24	16	36	18	28	14
2. Shielded metallic arc-weld heat and corrosion resistant (stainless) steels	33	27	29	8	34	22	24	16
3. Shielded metallic arc-weld carbon steel	27	4	14	49	24	8	64	4
4. Cut cast iron with air carbon arc process	43	22	24	6	56	14	26	2
5. Hard surface steel with arc-welding equipment	27	29	29	12	38	20	30	8
6. Cut carbon steels using shielded metallic arc cutting process	51	27	14	4	52	28	10	8
7. Cut carbon steels with air carbon arc process	39	24	20	12	38	8	22	30
8. Remove or replace SMAW equipment accessories	47	14	14	20	44	10	22	20
H. PERFORMING STRUCTURAL OR EQUIPMENT WELDING AND CUTTING OPERATIONS								
1. Fabricate aluminum structures or devices	39	31	18	8	36	12	22	26
2. Fabricate or repair tubing systems	37	16	29	14	52	14	24	8
3. Reconstruct and align frames or related equipment	35	20	29	12	48	14	24	12
4. Fabricate corrosion resistant steel	43	20	33	4	38	22	18	20

APPENDIX A-2

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS
BY LOCATION - 1978 (Continued)

Tasks	West Virginia N = 49				Pennsylvania N = 50			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
5. Fabricate protective devices for windows and openings	57	20	18	4	68	10	22	0
6. Fabricate metal reinforcing devices for structural foundations	57	20	14	4	64	6	26	4
7. Fabricate metal work stands or furniture	35	20	33	8	34	12	30	32
8. Fabricate or construct storage devices	29	22	35	10	32	16	32	18
9. Prepare and weld pipe joints	29	12	18	37	30	8	24	34
10. Cut metal using MAPP or propane type gas equipment	69	6	6	14	54	6	8	30
11. Set oven temperature and store arc electrodes	45	8	6	37	28	22	12	36

APPENDIX A-3

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978

1 = Never
2 = Seldom
3 = Sometimes
4 = Often

Tasks	1 - 5 Years N = 4				6 - 10 Years N = 9				Over 10 Years N = 86			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
A. SUPERVISION, TRAINING AND JOB ESTIMATING												
1. Assign work to others	25	75	-	-	22	11	11	56	17	7	7	64
2. Plan and schedule work assignments	50	50	-	-	22	11	22	44	22	5	7	62
3. Instructor checklist	75	25	-	-	89	-	-	11	51	2	8	35
4. Prepare annual shop budgets	75	25	-	-	78	-	11	11	59	12	6	20
5. Write performance standards for jobs	50	25	25	-	78	-	-	22	53	17	12	15
6. Conduct oral safety briefings	50	25	-	25	44	-	11	44	34	7	13	42
7. Improve work methods	50	-	25	25	33	-	22	44	22	1	35	37
8. Estimate cost of repairs	50	50	-	-	67	11	11	11	48	8	17	23
9. Estimate labor and material costs of new fabrication	25	50	25	-	78	11	-	11	45	13	19	20
10. Prepare accident report	50	50	-	-	56	11	22	11	34	28	16	19
11. Plan and conduct on-the-job training for employees	50	50	-	-	22	33	11	33	48	8	19	23
12. Instructor checklist	75	25	-	-	89	-	-	11	67	2	2	24
13. Interview job applicants	50	50	-	-	89	11	-	-	64	12	9	12
14. Receive and record new shipment of supplies	50	50	-	-	67	-	22	11	35	10	17	30
15. Read and interpret detail sketch from blueprint	50	50	-	-	22	-	44	33	24	3	24	42
B. SET UP, TACK AND WELD METAL PROCESSING PROJECTS												
1. Select metals for fabrication from blueprint specifications	75	-	25	-	33	-	22	44	33	6	24	33
2. Draw sketches for shop or field projects	75	-	25	-	33	11	11	44	30	10	28	27

APPENDIX A-3

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

Tasks	1 - 5 Years N = 4				6 - 10 Years N = 9				Over 10 Years N = 86			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
3. Research technical publications for welding standards	75	25	-	-	44	11	22	22	45	10	27	13
4. Set up and tack weld tee joints	-	-	75	25	11	11	11	67	13	3	10	69
5. Set up and tack weld upon butt joints	-	-	75	25	11	11	-	78	9	3	10	72
6. Set up and tack weld corner or edge joints	-	-	75	25	-	11	11	78	13	7	6	70
7. Set up and tack weld in the flat position	-	-	75	25	-	11	-	89	12	3	7	73
8. Set up and tack weld in the horizontal position	-	-	75	25	-	11	-	89	13	3	12	67
9. Set up and tack weld in the overhead position	-	-	75	25	-	11	-	89	16	16	7	56
10. Set up and tack weld in the vertical position	-	-	75	25	-	11	-	89	13	7	13	63
11. Set up and tack weld lap joints	-	-	75	25	-	11	11	78	15	7	16	57
12. Set up and make a plug or slat weld	50	-	50	-	-	11	44	44	22	12	27	35
13. Clamp metal work to prevent distortion and tack weld	-	-	50	50	22	-	11	67	15	6	20	55
C. CLEAN, TEST AND CLASSIFY METALS												
1. Examine and identify metals	50	-	50	-	11	-	56	33	21	8	28	38
2. Clean metals with solvent	50	25	25	-	44	-	33	22	37	23	22	14
3. Test metals using guided bend tester	50	50	-	-	67	11	-	22	42	8	14	33
4. Inspect welds using dye penetrant methods	50	50	-	-	56	22	-	22	51	16	23	6
D. OPERATING AUXILIARY EQUIPMENT AND TOOLS												
1. Chip slag using chipping hammer	-	25	25	50	-	-	11	89	12	3	7	74
2. Cut materials with hand hacksaws	25	25	50	-	11	-	56	33	19	23	31	23
3. Drill metal using power drilling equipment	-	-	50	50	11	-	22	67	17	8	34	37

APPENDIX A-3

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

Tasks	1 - 5 Years N = 4				6 - 10 Years N = 9				Over 10 Years N = 86			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
4. Grind metal with power equipment	-	-	25	75	-	11	-	89	6	5	15	71
5. Cut metal with power hacksaw	25	25	25	25	33	-	11	56	31	8	21	36
6. Wire brush with power equipment	25	-	-	75	22	11	22	44	20	8	29	40
7. Finish metal surfaces with hand tools	75	25	-	-	22	22	33	22	26	13	27	31
8. Shear and punch metal shapes using iron working machine(s)	50	25	-	25	56	-	22	22	60	3	13	21
E. OPERATING GAS WELDING EQUIPMENT												
1. Set up portable or stationary oxy-fuel equipment	-	25	75	-	11	-	22	67	14	5	16	62
2. Braze ferrous and non ferrous metals with gas equipment	25	25	50	-	22	11	22	44	19	14	23	41
3. Change oxygen, acetylene or MAPP gas cylinders	-	-	-	100	11	-	22	67	10	7	15	64
4. Clean welding and cutting tips on oxy-fuel equipment	-	-	75	25	11	-	11	78	10	2	16	67
5. Cut carbon steels with oxy-acetylene equipment	25	25	25	25	11	-	11	78	12	5	12	69
6. Forge metals with gas equipment	75	-	25	-	33	-	11	56	44	21	22	10
7. Gas weld cast iron	50	25	25	-	33	11	33	22	27	27	24	19
8. Gas weld copper or copper alloys	75	25	-	-	56	33	-	11	45	24	21	7
9. Silver braze copper pipe joints	75	25	-	-	78	-	11	11	29	37	24	6
10. Gas weld carbon steels	50	25	-	25	44	11	22	22	27	14	23	33
11. Braze repair castings	50	25	25	-	22	44	44	11	22	23	33	19
12. Lead solder ferrous and non ferrous metals with gas equipment	75	25	-	-	56	11	22	11	48	30	15	3
13. Perform soap and water and/or submerged leak test and repair gas welding equipment	25	25	-	50	44	-	22	33	33	15	23	26

APPENDIX A-3

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

Tasks	1 - 5 Years N = 4				6 - 10 Years N = 9				Over 10 Years N = 86			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
14. Shape metals using gas welding equipment	25	25	25	25	22	-	33	44	24	12	29	31
15. Silver braze ferrous metals with gas equipment	75	25	-	-	44	22	22	11	30	20	30	16
16. Silver braze non ferrous metals with gas equipment	75	-	25	-	56	22	11	11	36	27	27	7
17. Remove distortion using gas welding equipment	50	25	25	-	22	11	33	33	26	26	30	15
F. OPERATING METALLIC AND TUNGSTEN INERT GAS WELDING EQUIPMENT (TIG), (MIG)												
1. Weld aluminum or aluminum alloys with GMAW (MIG) equipment	25	25	-	50	56	11	11	22	29	21	19	28
2. Weld aluminum or aluminum alloys with GTAW (TIG) equipment	25	25	-	50	33	22	11	33	24	13	9	50
3. Weld stainless steel alloys with GMAW (MIG) equipment	25	25	25	25	44	11	11	33	40	26	16	16
4. Weld carbon steels with GMAW (MIG) equipment	-	25	25	50	11	11	11	67	16	12	13	56
5. Disassemble and clean a GMAW (MIG) torch assembly	-	25	50	25	11	11	44	33	16	10	28	42
6. Disassemble and clean a GTAW (TIG) torch assembly	25	25	25	25	33	11	33	22	27	15	20	35
7. Weld chrome-moly steel with GMAW (MIG) equipment	75	25	-	-	67	33	-	-	62	21	13	2
8. Weld copper or copper alloys with GTAW (TIG) equipment	75	25	-	-	67	22	11	-	53	20	21	2
9. Weld heat and corrosion resistant (stainless) steel with GTAW (TIG) equipment	50	25	-	25	44	11	22	22	41	15	20	20

APPENDIX A-3

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

	1 - 5 Years N = 4				6 - 10 Years N = 9				Over 10 Years N = 86			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
10. Weld carbon steels with GTAW (TIG) equipment	50	25	-	25	44	22	11	22	29	15	16	36
11. Weld magnesium alloys with GTAW (TIG) equipment	75	25	-	-	44	33	11	11	52	22	17	6
G. OPERATING SHIELDED MATALLIC ARC WELDING EQUIPMENT												
1. Shielded metallic arc-weld cast iron	50	25	25	-	44	11	33	11	30	23	26	16
2. Shielded metallic arc-weld heat and corrosion resistant (stainless) steel	50	25	25	-	44	11	33	11	31	26	26	13
3. Shielded metallic arc-weld carbon steel	50	25	-	25	33	-	11	56	23	1	12	58
4. Cut cast iron with air carbon arc process	75	25	-	-	56	22	22	-	48	17	27	5
5. Hard surface steel with arc-welding equipment	50	25	25	-	33	44	22	-	31	22	30	12
6. Cut carbon steels using shielded metallic arc cutting process	75	25	-	-	44	22	22	11	51	28	12	6
7. Cut carbon steels with air carbon arc process	50	25	25	-	33	11	11	44	38	16	22	20
8. Remove or replace SMAW equipment accessories	75	25	-	-	56	11	-	33	43	12	21	20
H. PERFORMING STRUCTURAL OR EQUIPMENT WELDING AND CUTTING OPERATIONS												
1. Fabricate aluminum structure or devices	50	25	-	25	44	22	11	22	36	21	22	16
2. Fabricate or repair tubing systems	50	25	-	25	56	11	22	11	43	15	28	10
3. Reconstruct and align frames or related equipment	50	25	-	25	44	11	33	11	41	17	27	12
4. Fabricate corrosion resistant steel	50	25	-	25	33	22	44	-	41	21	24	10

APPENDIX A-3

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

Tasks	1 - 5 Years N = 4				6 - 10 Years N = 9				Over 10 Years N = 86			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
5. Fabricate protective devices for windows and openings	75	25	-	-	67	11	22	-	62	15	21	2
6. Fabricate metal reinforcing devices for structural foundations	75	25	-	-	44	11	33	11	62	13	20	3
7. Fabricate metal work stands or furniture	75	25	-	-	22	11	44	22	34	16	31	15
8. Fabricate or construct storage devices	50	25	-	25	22	22	33	22	30	19	35	13
9. Prepare and weld pipe joints	50	-	25	25	33	-	33	33	28	12	20	36
10. Cut metal using MAPP or propane type gas equipment	50	25	25	-	67	-	11	22	62	6	6	23
11. Set oven temperature and store arc electrodes	25	50	-	25	67	-	-	33	34	15	10	37

APPENDIX A-4

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978

1 = Never
2 = Seldom
3 = Sometimes
4 = Often

Tasks	Welders N = 14				Supervisors N = 26				Instructors N = 44			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
A. SUPERVISION, TRAINING AND JOB ESTIMATING												
1. Assign work to others	43	14	29	14	8	8	4	77	11	7	2	75
2. Plan and schedule work assignments	50	14	21	14	8	8	12	69	18	5	2	70
3. Instructor checklist	86	-	7	7	69	4	8	12	30	2	9	57
4. Prepare annual shop budgets	93	-	-	7	69	12	8	8	43	16	7	30
5. Write performance standards for jobs	93	7	-	-	65	19	8	4	39	9	20	30
6. Conduct oral safety briefings	79	-	7	14	35	8	23	31	18	5	9	64
7. Improve work methods	43	-	29	29	8	46	42	4	16	2	32	45
8. Estimate cost of repairs	64	14	14	7	65	15	19	4	39	14	20	25
9. Estimate labor and material costs of new fabrication	79	14	-	7	58	8	8	23	32	11	34	20
10. Prepare accident report	86	7	7	-	27	31	19	19	14	36	23	23
11. Plan and conduct on-the-job training for employees	57	36	-	7	31	12	31	23	43	7	1[illegible]	32
12. Instructor checklist	100	-	-	-	81	8	8	4	48	5	43	5
13. Interview job applicants	86	7	-	7	58	15	12	12	66	11	9	11
14. Receive and record new shipment of supplies	64	7	14	7	46	8	27	15	18	16	16	43
15. Read and interpret detail sketch from blueprint	50	7	14	21	19	4	23	50	14	5	30	48
B. SET UP, TACK AND WELD METAL PROCESSING PROJECTS												
1. Select metals for fabrication from blueprint specifications	43	-	-	57	38	8	19	31	16	7	36	36
2. Draw sketches for shop or field projects	43	7	21	29	38	27	12	19	14	2	41	39

APPENDIX A-4

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Welders N = 14				Supervisors N = 26				Instructors N = 44			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
3. Research technical publications for welding standards	57	14	7	21	50	12	19	15	32	14	41	9
4. Set up and tack weld tee joints	14	7	36	43	8	4	12	69	2	7	86	5
5. Set up and tack weld upon butt joints	7	7	36	50	8	4	12	69	2	7	86	5
6. Set up and tack weld corner or edge joints	14	7	29	50	8	8	4	73	2	2	9	82
7. Set up and tack weld in the flat position	14	7	12	57	8	4	4	77	2	5	89	5
8. Set up and tack weld in the horizontal position	14	7	21	57	8	4	19	62	2	7	86	5
9. Set up and tack weld in the overhead position	14	7	29	50	12	31	8	42	5	5	7	80
10. Set up and tack weld in the vertical position	14	7	21	57	8	12	23	50	2	9	84	5
11. Set up and tack weld lap joints	21	7	21	50	12	12	23	46	2	2	16	75
12. Set up and make a plug or slat weld	29	-	29	43	8	15	23	46	11	16	39	30
13. Clamp metal work to prevent distortion and tack weld	29	-	14	57	8	4	27	54	5	5	18	68
C. CLEAN, TEST AND CLASSIFY METALS												
1. Examine and identify metals	29	7	36	29	27	15	31	23	9	32	55	5
2. Clean metals with solvent	43	7	36	14	38	23	12	23	32	23	30	11
3. Test metals using guided bend tester	64	14	21	-	69	15	8	8	16	7	11	61
4. Inspect welds using dye penetrant methods	57	29	-	14	42	23	19	12	52	14	25	5
D. OPERATING AUXILIARY EQUIPMENT AND TOOLS												
1. Chip slag using chipping hammer	7	-	29	64	8	12	4	73	5	5	86	5
2. Cut materials with hand hacksaws	21	29	29	21	19	27	27	23	5	14	48	30
3. Dril metal using power drilling equipment	21	7	36	36	19	12	8	58	2	5	50	39

APPENDIX A-4

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Welders N = 14				Supervisors N = 26				Instructors N = 44			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
15. Silver braze ferrous metals with gas equipment	50	21	14	14	42	27	23	4	14	16	41	25
16. Silver braze non ferrous metals with gas equipment	57	14	21	7	46	27	19	4	20	32	32	11
17. Remove distortion using gas welding equipment	36	7	29	29	23	38	27	8	14	23	39	20
F. OPERATING METALLIC AND TUNGSTEN INERT GAS WELDING EQUIPMENT (TIG), (MIG)												
1. Weld aluminum or aluminum alloys with GMAW (MIG) equipment	36	14	21	29	38	19	15	23	23	18	18	36
2. Weld aluminum or aluminum alloys with GTAW (TIG) equipment	36	21	-	43	42	19	8	27	7	7	9	73
3. Weld stainless steel alloys with GMAW (MIG) equipment	29	29	21	21	31	23	23	19	45	20	11	20
4. Weld carbon steels with GMAW (MIG) equipment	21	29	14	36	12	19	8	58	9	2	14	70
5. Disassemble and clean a GMAW (MIG) torch assembly	14	14	43	29	15	15	12	54	11	2	36	45
6. Disassemble and clean a GTAW (TIG) torch assembly	36	14	14	36	35	19	15	27	11	9	30	45
7. Weld chrome-moly steel with GMAW (MIG) equipment	57	43	-	-	69	12	12	4	57	20	18	2
8. Weld copper or copper aloys with GTAW (TIG) equipment	57	21	7	14	62	12	19	4	48	23	25	5
9. Weld heat and corrosion resistant (stainless) steel with GTAW (TIG) equipment	57	14	7	21	54	19	12	12	23	11	34	25
10. Weld carbon steels with GTAW (TIG) equipment	57	29	14	-	38	23	19	15	11	5	16	61
11. Weld magnesium alloys with GTAW (TIG) equipment	64	21	7	7	65	15	15	4	32	30	25	11

APPENDIX A-4

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Welders N = 14				Supervisors N = 26				Instructors N = 44			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
4. Grind metal with power equipment	7	-	36	57	4	8	4	81	2	5	89	5
5. Cut metal with power hacksaw	29	14	7	50	31	8	23	35	23	7	23	43
6. Wire brush with power equipment	7	14	36	43	8	19	35	35	20	2	20	52
7. Finish metal surfaces with handtools	29	21	29	21	35	19	27	15	14	9	27	45
8. Shear and punch metal shapes using iron working machine(s)	64	7	14	14	62	4	8	23	52	5	16	25
E. OPERATING GAS WELDING EQUIPMENT												
1. Set up portable or stationary oxy-fuel equipment	14	7	12	57	23	4	27	42	2	2	11	80
2. Braze ferrous and non ferrous metals with gas equipment	14	21	36	29	31	19	23	23	2	5	27	61
3. Change oxygen, acetylene or MAPP gas cylinders	14	7	7	71	12	8	23	54	5	2	7	82
4. Clean welding and cutting tips on oxy-fuel equipment	7	-	43	50	15	19	62	4	2	2	7	84
5. Cut carbon steels with oxy-acetylene equipment	14	21	14	50	8	4	15	69	7	7	82	5
6. Forge metals with gas equipment	36	21	21	21	65	15	12	8	27	23	32	14
7. Gas weld cast iron	21	36	29	14	38	31	19	8	7	23	36	30
8. Gas weld copper or copper alloys	43	36	14	7	50	27	15	4	39	27	23	9
9. Silver braze copper pipe joints	43	29	29	-	42	31	15	8	23	41	25	7
10. Gas weld carbon steels	36	21	29	14	35	31	15	15	7	5	30	55
11. Braze repair castings	21	50	21	7	35	31	23	8	5	11	50	30
12. Lead solder ferrous and non ferrous metals with gas equipment	64	21	7	7	65	15	15	4	34	39	16	7
13. Perform soap and water and/or submerged leak test and repair gas welding equipment	36	14	36	14	54	8	19	15	11	16	20	48
14. Shape metals using gas welding equipment	21	29	29	12	35	23	23	15	5	2	34	55

APPENDIX A-4

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Welders N = 14				Supervisors N = 26				Instructors N = 44			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
G. OPERATING SHILDED METALLIC ARC WELDING EQUIPMENT												
1. Shielded metallic arc-weld cast iron	50	21	21	7	42	27	23	4	7	20	36	30
2. Shielded metallic arc-weld heat and corrosion resistant (stainless) steel	57	21	14	7	42	23	23	8	9	27	39	18
3. Shielded metallic arc-weld carbon steel	43	7	14	36	31	15	50	4	9	2	9	70
4. Cut cast iron with air carbon arc process	64	14	21	-	50	23	19	4	34	23	32	7
5. Hard surface steel with arc-welding equipment	36	36	14	14	38	23	23	12	16	30	36	11
6. Cut carbon steels using shielded metallic arc cutting process	64	29	7	-	58	27	12	4	30	34	20	11
7. Cut carbon steels with air carbon arc process	50	14	7	29	38	15	15	27	20	20	36	18
8. Remove or replace SMAW equipment accessories	50	21	21	7	58	8	15	15	20	14	25	34
H. PERFORMING STRUCTURAL OR EQUIPMENT WELDING AND CUTTING OPERATIONS												
1. Fabricate aluminum structure or devices	43	21	7	29	50	19	4	23	23	23	34	14
2. Fabricate or repair tubing systems	36	7	21	36	42	12	23	19	43	18	32	2
3. Reconstruct and align frames or related equipment	36	21	21	21	46	15	12	23	32	18	41	5
4. Fabricate corrosion resistant steel	43	14	29	14	38	23	19	15	36	25	30	5
5. Fabricate protective devices for windows and openings	79	14	7	-	77	12	8	4	43	18	36	2
6. Fabricate metal reinforcing devices for structural foundations	71	14	7	7	62	8	19	8	52	18	27	2

APPENDIX A-4

WELDING

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Welders N = 14				Supervisors N = 26				Instructors N = 44			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
7. Fabricate metal work stands or furniture	57	21	14	7	46	23	19	8	14	9	50	23
8. Fabricate or construct storage devices	43	21	14	21	35	27	23	12	18	16	45	16
9. Prepare and weld pipe joints	36	7	14	43	35	12	19	31	14	9	25	45
10. Cut metal using MAPP or propane type gas equipment	50	7	21	21	62	4	4	27	61	7	5	23
11. Set oven temperature and store arc electrodes	50	21	7	21	42	19	12	33	25	7	7	57

APPENDIX A-5

WELDING

REVALIDATION OF TOOLS AND EQUIPMENT
1978

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia N=49	Pennsylvania N=50	1-5 Years N=4	6-10 Years N=9	Over 10 Years N=86	Welder N=14	Supervisor N=26	Educator N=44
	%	%	%	%	%	%	%	%
1. Anvil	71	64	75	67	67	29	62	89
2. Apron Welding	55	78	75	56	67	50	65	80
3. Angle Dividers	59	52	25	67	56	36	46	75
4. Air Compressor	73	68	50	89	70	64	81	68
5. Band Saw Blade Welder	27	26	25	44	24	21	31	25
6. Box and Pan Break	10	18	25	33	12	14	12	16
7. Brush, Bench	59	72	50	67	66	64	73	64
8. Brush, Wire	92	96	75	89	95	86	100	95
9. Chisel, Cold	96	92	75	89	95	86	92	100
10. Chisel, Impact	43	50	50	56	45	57	69	27
11. Clamp, Vice Grips	88	90	75	89	90	86	73	100
12. Clamp Bar, Quick Acting	39	64	25	44	53	14	65	57
13. Clamps, C Type	98	100	100	100	99	100	100	100
14. Clamp, Quick Release Chain	27	40	50	22	34	21	46	30
15. Crayons, Soapstone	96	94	75	100	95	100	96	98
16. Crayons, Heat	49	62	25	56	57	50	50	55
17. Cutter, Bolt	37	32	50	44	33	36	46	25
18. Cutter, Pipe	55	40	75	56	45	43	62	45
19. Cutting Machine, Straight Line Flame	73	70	75	78	71	43	62	93
20. DC Power Source Motor, Driven Gasoline	55	48	75	44	51	57	50	50
21. Drill, Electric 1/4 Inch	63	66	50	67	65	43	73	73
22. Drill, Electric 3/8 Inch	71	54	50	67	63	50	73	70
23. Drill, Electric 1/2 Inch	69	68	50	89	67	57	73	80
24. Drill, Twist, Letter Set	39	30	25	56	33	21	35	39
25. Drill, Twist, Number Set	43	42	25	56	42	50	38	43

APPENDIX A-5

WELDING

REVALIDATION OF TOOLS AND EQUIPME .
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia N=49	Pennsylvania N=50	1-5 Years N=4	6-10 Years N=9	Over 10 Years N=86	Welder N=14	Super-visor N=26	Educator N=44
	%	%	%	%	%	%	%	%
26. Drill Stand, Fractional	33	50	50	44	41	29	46	45
27. Drill, Twist Straight Shank, Fractional Set	41	48	25	33	47	21	54	48
28. Drill Press	86	74	75	89	79	71	81	91
29. Dresser, Abrasive Wheel	82	72	75	78	77	57	77	91
30. Die Tapping	53	42	50	56	47	43	50	50
31. Die Letter Set	45	42	25	33	45	36	42	52
32. Die Number Set	49	44	100	33	50	43	42	57
33. Extractor Screw Set	43	30	100	22	35	36	42	36
34. Files, Flat Bastard Double Cut	90	78	75	89	84	71	81	98
35. Files, Mill Smooth	61	62	50	56	63	36	73	73
36. Files, Mill	63	58	100	67	63	43	69	68
37. Files, Round Bastard	84	74	50	78	80	64	77	93
38. Files, Round Second-Cut	55	52	50	44	55	36	62	64
39. Files, Three-Square Second-Cut	49	38	50	44	43	29	54	50
40. File Card and Brush	41	40	50	67	37	21	31	55
41. Gauge, Fillet	61	78	50	78	70	43	69	82
42. Gloves, Asbestos Pair	43	44	50	33	44	43	46	43
43. Gloves, Leather Pair	94	94	75	100	94	100	96	100
44. Gloves, Thick Rubber Pair	16	12	25	33	12	29	27	5
45. Goggle, Brazing	94	88	75	89	92	93	96	98
46. Grinder Belt	18	30	25	22	24	29	50	7
47. Grinder Pedestal	69	78	50	67	76	43	81	91
48. Grinder, Portable	94	92	75	89	94	86	100	100
49. Grinder, Surface	29	40	50	44	33	57	42	25
50. Guided Bend Tester	49	56	50	44	53	14	31	82

APPENDIX A-3

WELDING

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia N=50	Pennsylvania N=50	1-5 Years N=4	6-10 Years N=9	Over 10 Years N=86	Welder N=14	Supervisor N=26	Educator N=44
	%	%	%	%	%	%	%	%
51. Hammer, Ball Peen	96	96	75	89	98	93	100	98
52. Hammer, Sledge	90	78	75	89	84	86	88	89
53. Hammer, Chipping	96	94	100	100	94	93	96	95
54. Hammer, Soft Face	35	48	50	56	40	43	54	34
55. Hardness Tester	8	12	25	100	10	7	4	9
56. Helmet, Grind Face Shield	88	88	50	100	88	86	92	93
57. Helmet, Welding Arc Head Type	98	96	75	100	98	100	96	100
58. Heat Treating Oven	18	14	50	100	16	29	19	7
59. Hydraulic Jack	65	52	25	78	58	50	69	59
60. Hydraulic Pipe Bender	18	10	25	33	12	36	15	2
61. Iron Working Machine	27	24	100	33	26	21	23	32
62. Mallet, Rawhide	18	30	25	11	26	21	31	18
63. Mallet, Rubber	29	28	50	33	27	29	38	20
64. Metal Identification Kits	20	24	25	100	24	14	23	18
65. Metallographic Polisher	4	8	25	100	6	100	100	7
66. Nipper, End Cutting	24	40	25	11	35	29	35	27
67. Parallels, Adjustable	16	14	25	22	14	100	19	18
68. Pencil, Air Grinders	47	44	25	33	48	43	69	41
69. Pipe Beveling Machine	37	32	50	11	36	29	12	55
70. Pliers, Combination	82	78	75	78	80	71	81	93
71. Pliers, Diagonal Cutting	78	66	50	78	72	50	85	77
72. Pliers, Needle Nose	69	74	75	67	72	79	73	70
73. Pliers, Straight Nose	51	62	25	56	58	57	65	52
74. Pliers, Vice-Grip Wrench	76	72	75	67	74	50	77	84
75. Power Roll	20	20	25	33	19	36	23	14
76. Power Shear	18	28	25	44	21	43	8	27
77. Punch Center	86	74	75	89	79	79	81	86
78. Punch Drive	24	32	25	44	27	36	38	25
79. Quenching Tank	67	64	75	67	65	50	38	91
80. Reamer, Pipe	27	20	25	33	22	36	38	11

APPENDIX A-5

WELDING

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia N=49	Pennsylvania N=50	1-5 Years N=4	6-10 Years N=9	Over 10 Years N=86	Welder N=14	Supervisor N=26	Educator N=44
	%	%	%	%	%	%	%	%
81. Rule, Circumference 36 Inch	33	28	100	44	30	21	31	36
82. Rule, Flexible Steel Tape 10 Ft-12 Ft	94	96	100	89	95	93	100	95
83. Rule, Hook	10	18	100	22	14	29	8	14
84. Rule, Short Set	3	12	100	22	9	14	8	9
85. Rule, Steel 6 Inch	49	50	25	44	51	71	62	41
86. Rule, Steel 12 Inch	61	48	25	56	56	50	58	59
87. Rule, Steel 24 Inch	39	32	100	44	36	21	38	39
88. Saw, Hack Hand	90	78	50	89	85	71	88	100
89. Saw, Hack Power	41	50	50	56	44	57	50	43
90. Saw, Band Power	61	58	25	78	59	57	69	61
91. Shear, Alligator Jaw	10	18	100	22	14	14	15	18
92. Shear, Nibbler Portable	16	24	100	44	19	21	15	20
93. Shear, Slitting	8	10	100	11	9	14	100	11
94. Shear, Squaring Foot	6	10	100	11	8	7	100	11
95. Screwdrivers, Phillips	82	84	100	78	83	64	88	91
96. Screwdrivers, Standard Bit	88	84	50	89	87	71	96	93
97. Sparklighters	98	90	100	100	93	100	96	100
98. Slip Roll Former	4	8	100	11	6	7	8	5
99. Square, Combination	94	84	75	89	90	86	88	100
100. Square, Framing	82	68	75	78	74	71	65	89
101. Tensile Testing Machine	16	20	100	100	21	7	4	32
102. Tongs, Blacksmith Curved Lip	41	40	25	56	40	29	35	57
103. Tongs, Pick-up	39	52	50	33	47	29	50	55
104. Truck Welding Cylinder	55	64	50	78	58	50	50	73
105. V Block and Clamps Set	20	42	100	33	33	36	31	30

APPENDIX A-5

WELDING

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia N=49	Pennsylvania N=50	1-5 Years N=4	6-10 Years N=9	Over 10 Years N=86	Welder N=14	Super-visor N=26	Educator N=44
	%	%	%	%	%	%	%	%
106. Vise, Angle Drill	33	20	50	22	28	21	42	23
107. Vise, Bench Drill	47	60	50	33	56	36	54	66
108. Vise Pin Set	6	12	100	11	9	14	15	5
109. Vise Pipe	37	38	100	33	40	36	46	32
110. Welder, Arc AC	90	96	75	89	94	93	96	93
111. Welder, Flux-Cored	49	74	50	56	63	43	65	61
112. Welder, MIG	84	88	50	78	88	79	81	93
113. Welder, Spot	29	54	25	67	40	29	46	45
114. Welder, Submerged ARC	24	44	25	44	34	36	42	27
115. Welder, TIG	61	80	25	56	74	50	58	89
116. Welder, Oxy-Acetylene	96	84	100	78	91	93	81	95
117. Welder, MAPP Gas	16	32	25	100	27	14	23	30
118. Wrench, Impact	45	30	50	56	35	50	77	7
119. Wrench, Adjustable End	90	80	100	78	85	79	85	95
120. Wrench, Allen Key Hex Set	80	86	75	89	83	79	88	95
121. Wrench Box Set	76	68	50	78	72	50	77	80
122. Wrench, Open End Set	67	68	75	78	66	57	73	75
123. Wrench, Pipe	88	66	100	67	77	71	73	84
124. Wrench, Socket 3/8 Inch Drive Set	55	44	50	56	49	29	65	55
125. Wrench, Socket 1/2 Inch Drive Set	63	54	75	56	58	57	77	52
126. Wrench, Gas Torch	73	86	50	78	81	71	73	91
127. Rod Oven	61	78	50	56	72	57	69	80

APPENDIX B

ADDITIONAL TOOLS AND EQUIPMENT

APPENDIX B

WELDING

ADDITIONAL TOOLS AND EQUIPMENT

The following items were added by respondents to the tools/ equipment list of the occupational inventory survey:

FIXED EQUIPMENT

1. Come-along
2. Crane, bench (1/2 ton)
3. Crane, boom
4. Crane, job
5. Crane, overhead
6. Falls, chain
7. Forklift, battery powered
8. Forklift, propane powered
9. Hoist, chain (1, 1-1/2 and 2-ton)
10. Hoist, electric
11. Hoist, portable cable (1 ton)
12. Jacks, hydraulic
13. Slings

1. Bender, metal
2. Brake, power (25-ton)

3. Brush, pedestal wire wheel
4. Brush, power

5. Generator, (AC), gasoline engine driven
6. Generator (DC), electric motor driven

7. Grinders, air (angle type, straight type)
8. Lathe (24")

9. Machine, abrasive cut-off
10. Machine, cutting, template
11. Machine, pattern cutting
12. Machine, plasma arc shape-cutting
13. Machine, pipe beveling

14. Press, arbor
15. Press, drill, magnetic (1-1/2")
16. Press, hydraulic (25, 30, 50-ton)
17. Press, punch

18. Roller, weldment turning

ADDITIONAL TOOLS AND EQUIPMENT (Continued)

19. Saw, stone cut-off (abrasive wheel)
20. Saw, skill (with abrasive wheel)
21 Sharpener, drill bit
22. Shear, beverly
23. Shear, cut-off, bar and angle iron
24. Shear, power, hydraulic (6' blade)
25. Shear, throatless

26. Vise, bench (5", 6")
27. Wheel, power cut-off
28. Furnace, normalizing and stress-relieving
29. Ovens, pre-heat
30. Ovens, post-heat

31. Sandbox (for annealing cast iron)

32. Sandblaster
33. Sander, belt
34. Sander, disc

35. Tank, chemical cleaning
36. Tanks, sand and lime

37. Baths, low temperature testing
38. Tester, bend
39. Tester, tong (volt, amp)
40. Testing equipment, drop weight

SHOP FURNISHINGS AND EQUIPMENT

1. Booths, welding (with curtains)
2. Platens, fitting table (5' x 5')
3. Tables, cast iron welding
4. Table, elevating
5. Table, layout
6. Tables, metal (1" - 2")top thickness, 6' x 12')
7. Tables, welding work

8. Rod room

9. Tool cabinet

10. Blowers, air exhaust
11. Blowers, portable
12. Vacuum

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13. Boxes, scrap
14. Buckets, flux
15. Carts, portable oxy-acetylene

ADDITIONAL TOOLS AND EQUIPMENT (Continued)

SAFETY EQUIPMENT

1. Fire blanket
2. Fire extinguishers
3. First aid kit
4. Glasses, safety, shaded and clear
5. Goggles, safety/flash (with wire side shields)
6. Gloves, leather (mitts and fingers)
7. Hats, hard
8. Welding aprons (leather)
9. Welding capes (leather)
10. Welding jackets (leather)
11. Welding sleeves (leather)

WELDING EQUIPMENT

1. Arrestors, hydraulic flash-back (fuel gas, acetylene)
2. Bars, burning
3. Burner, circle
4. Electrode holders
5. Gauging equipment, carbon arc
6. Hoses, air, high pressure
7. Manifold system, oxygen, acetylene, argon, CO_2
8. Soldering irons (100, 200, 300 watt)
9. Tip cleaners
10. Tip drill kit
11. Torch, arc air
12. Torch, carbon arc
13. Torch, fuse weld (metal spraying)
14. Torch, pattern cutting
15. Torch, powder spraying
16. Torch, propane
17. Torch, radial oxy-acetylene hand-cutting
18. Torch, radiograph
19. Torch, travel (for burning test plates)
20. Welder, AC-DC
21. Welder, AC-DC (portable, gas-driven)
22. Welder, Arc DC rectifier
23. Welder, automatic MIG
24. Welder, automatic TIG
25. Welder, automatic spot

ADDITIONAL TOOLS AND EQUIPMENT (Continued)

26. Welder, flash
27. Welder, plasma arc
28. Welder, plastic
29. Welder, spot and seam resistance
30. Welding equipment, electroslag
31. Welding unit, flux cored, portable
32. Welding and cutting unit, oxy-fuel, portable

TOOLS

1. Angle iron combination: shear, notcher, bender
2. Bars, line-up
3. Bars, pinch (1', 2', 5')
4. Brushes, stainless steel (for aluminum)
5. Burrs, car (1-1/8", 1-1/4")

6. Clamps, corner
7. Clamps, line-up (outside, inside)

8. Cleaners, tip

9. Crowbar

10. Cutter, circle
11. Cutting tool, jacket stripping and cable cutting

12. Die check
13. Dye penetrant (for weld testing kit)

14. Electric drop lights
15. Electric extension cords
16. Spotlight, projector

17. Gun, stud

18. Hammer, chipping, air
19. Hammer, Chipping, hand

20. Level, 24"
21. Level, pro-mag

22. Lug set block and punch

23. Notcher, corner

24. Peening tools, air-driven
25. Peening tools, hand

26. Platen

ADDITIONAL TOOLS AND EQUIPMENT (Continued)

27. Pliers, slip-joint, heavy duty
28. Pliers, vise grip, sheet metal

29. Plumb Bobs

30. Snips, aviation
31. Snips, tin

32. Twister, manual picket (for 1/2" solid square block)

33. Wedges

34. Weld crabs
35. Weld positioners and centers for shafting

36. Wrench, adjustable
37. Wrench, socket (3/4" drive)

38. Awls, scratch

39. Calipers, inside
40. Calipers, outside

41. Marker, radius

42. Ruler, extension (72")
43. Ruler, straight edge (24")

44. Scribers

45. Tee square
46. Tee square, bevel

APPENDIX C

ADDITIONAL TASKS

APPENDIX C

WELDING

ADDITIONAL TASKS

The following tasks were added by respondents to the task list of the occupational inventory survey:

A. SUPERVISION, TRAINING AND JOB ESTIMATING

1. Record job numbers, repaired and new parts
2. Plan and budget indirect labor
3. Take yearly inventory
4. Weekly safety talks
5. Determine need for welding data
6. Plan weld experiments
7. Train students as shop foremen involved in training
8. Train students to evaluate their own welder joints

B. SET UP, TACK AND WELD METAL PROCESSING PROJECTS

1. Preheat
2. Button weld
3. Set up and weld pipe in horizontal fixed position
4. Pipe welding
5. Lock weld broken castings and chamfer for welding
6. High pressure testing

C. CLEAN, TEST AND CLASSIFY METALS

1. Visual inspection of welds
2. File metals to identify
3. High pressure with water and hydraulic oil testing
4. X-ray welds
5. Ultrasonic testing
6. Spark grind test
7. Tensile and pull test
8. Inspect welds using xylol test
9. Inspect welds using magnaflux test
10. Inspect welds using acid test
11. Inspect welds using magnetic particle test
12. Inspect metal parts for cracks using dyes and black light
13. Side bend test using divided bend tester
14. Etch weld speciments with acid

ADDITIONAL TASKS (Continued)

D. OPERATING AUXILIARY EQUIPMENT AND TOOLS

1. Operate resistance welder (spot welder)
2. Shear metal using hydraulic shear
3. Cut metals and pipe with stone saw
4. Cut materials with nibbler
5. Cut metal with power band saw
6. Cut metal with radial cutoff
7. Cut and gouge metal with air-arc process
8. Flame cut and bevel
9. Peen metals using air-driven peen
10. Clean welds with wire wheel
11. Polish metal with power equipment
12. Welding build-up work and turn with metal lathe
13. Chip slag using pneumatic gun or hammer
14. Make minor repairs to machines and tools

E. OPERATING GAS WELDING EQUIPMENT

1. Preheat large castings before welding
2. Gas weld light gage metal
3. Gas weld heavy gage metal (all positions)
4. Gas weld pipe
5. Gas weld white or pot metals
6. Gas weld for hard surfacing
7. Gas weld aluminum
8. Gas weld pipe, 1" to 3" diameter
9. Hard facing
10. Braze weld mild steel
11. Fusion weld on thin metal
12. Spray weld using powdered metal
13. Operate automatic radiograph cutting equipment
14. Radial and straight line cutting and beveling

F. OPERATING METALLIC AND TUNGSTEN INERT GAS WELDING EQUIPMENT (TIG), (MIG)

1. Set up GTAW power source and accessories
2. Set up GMAW power source and accessories
3. Braze with TIG
4. Weld high speed tool steels with TIG
5. Automatic machine butt weld on aluminum
6. Join carbon steel and galvanized steel with de-ox copper
7. Weld tool and die steels (all grades)
8. Submerged arc welding of mine locomotive wheels
9. Perform periodic maintenance on equipment

ADDITIONAL TASKS (Continued)

G. OPERATING SHIELDED METALLIC ARC WELDING EQUIPMENT

1. Set up and adjust SMAW equipment
2. Position weld plate overhead, horizontal and vertical
3. Position weld pipe overhead, horizontal and vertical
4. Weld sheet metal
5. Shielded metallic arc weld hot work steel
6. Shielded metallic arc weld chrome nickel steel
7. Shielded metallic arc weld chrome moly steel
8. Braze with carbon electrode
9. Cut stainless steel with air carbon
10. Cut aluminum with air carbon
11. Cut brass with air carbon
12. Repair and maintain all SMAW equipment accessories
13. Blow out welders at certain intervals
14. Perform periodic maintenance

H. PERFORMING STRUCTURAL OR EQUIPMENT WELDING AND CUTTING OPERATIONS

1. Braze thin metals
2. Fabricate electrical enclosures for coal mines
3. Fabricate mine machinery, conveying equipment, and pneumatic shooting equipment
4. Fabricate jigs and fixtures
5. Fabricate heat treat baskets for salt bath using carbon steel
6. Fabricate ornamental railings, posts for student built houses
7. Fabricate pressure casting die holders
8. Fabricate railings and banisters
9. Fabricate sheet metal
10. Fabricate spiral staircases
11. Fabricate trailers
12. Fabricate trailer hitches
13. Fabricate pressure casting die holders
14. Fabricate welding carts for gas rigs
15. Fabricate wood burning stoves
16. Fabricate structural steel components